

To: Staci Goodwin, TMDL Program Manager, IDEM
From: Rhett Moore, Senior Hydrologist, WHPA Inc.
Date: September 24, 2003
Subject: Salt Creek Watershed and Water Quality Modeling / Analytic Report

TECHNICAL MEMORANDUM

This memorandum describes WHPA's efforts in implementing the Modeling Framework for development of an *E. coli* TMDL for Salt Creek, Porter County, Indiana. A comprehensive watershed/water-quality model was developed, calibrated, and verified. The calibrated model will be applied in subsequent activities to identify the cause and effect relationship between sources and attainment and to evaluate potential future *E. coli* allocations.

The following aspects of model development will be discussed:

1. Approach
2. Hydrologic Calibration and Verification
3. Water Quality Calibration
4. References
5. Attachments

1 APPROACH

1.1 Analytical Framework and Model Setup

WHPA's analytical framework for development of a Salt Creek TMDL is presented in detail in the Modeling Framework Report [WHPA, 2003b]. The technical model requirements outlined in the Modeling Framework dictated that the model or models used for TMDL development be capable of simulating 1.) bacteria loading on a watershed scale, 2.) hydrology, and 3.) in-stream processes and *E. coli* transport. It was also essential that the model be able to simulate the above aspects at a time step appropriate for analysis of storm events.

HSPF was chosen as the best choice for development of an *E. coli* TMDL for Salt Creek. The model, as packaged with BASINS 3.0, is very suitable for fulfilling the technical model requirements. HSPF is a comprehensive, dynamic simulation model capable of simulating point and nonpoint source runoff and pollutant loading for a watershed. In addition, the model can simulate flow and water-quality routing in stream reaches [U.S. EPA, 2001, Bicknell et al., 2001].

Table 1: Data sets used for model implementation.

Data Type	Use	Source	Reference	Description
Land Use/Land Cover	Input	USGS	[USGS, 2000]	Land use classifications: 1:24,000 scale
Soils	Input	USDA	[U.S. Department of Agriculture, 1994] [U.S. Department of Agriculture, 2002]	Soil physical properties: 1:250,000 scale
Topography	Input	USGS	[U.S. Geological Survey, 1999]	Digital Elevation Model: 1:24,000 scale
Climate	Input	NCDC	[NCDC, 2002]	Climate from Valparaiso
Point Sources	Input	IDEM	[WHPA, 2003c, WHPA, 2003a]	Flow and contaminant inputs from point sources
Nonpoint Sources	Input	WHPA	[WHPA, 2003c]	Estimated loads from nonpoint sources
Flows	C/V	USGS	[WHPA, 2003a]	Daily Flow Values from McCool Gage
<i>E. coli</i> concentrations	C/V	Various	[WHPA, 2003a]	<i>E. coli</i> concentrations measured in Salt Creek

USGS=U.S. Geological Survey, USDA=U.S. Department of Agriculture, NCDC=National Climatic Data Center, WHPA=Wittman Hydro Planning Associates, C/V= Calibration/Verification

HSPF can be accessed in BASINS 3.0 through an interface called WinHSPF [Duda et al., 2001]. Earlier versions of the interface were known as the Nonpoint Source Model. WinHSPF was developed to ease the complexity of building and modifying input files for HSPF to enhance the modeler's ability to understand and represent model output.

The general approach outlined in the Modeling Framework is shown in the schematic in Figure 1. The BASINS platform was used to setup a WinHSPF model of the Salt Creek watershed. Table 1 presents detailed information regarding the various data sets used for model implementation. WinHSPF's integrated design with BASINS 3.0 streamlines the process of setting up an HSPF model. Functions in the BASINS 3.0 GIS interface create a series of input files for initial WinHSPF model setup. The land use/land cover, soils, and topography data (Table 1) were used with BASINS 3.0 to create three setup files for WinHSPF: the watershed file, the reach file, and the channel geometry file. The watershed file provides information to WinHSPF related to land use distributions. The reach file provides information regarding each stream reach and the connections between reaches. The channel geometry file provides information related to channel cross-sections and lengths for each stream reach. The WinHSPF model of Sugar Creek was setup with 36 reaches. Figure 2 shows the layout for the model reaches.

Watershed simulation combines the physical characteristics of the watershed, such as those described above, with climate and source loading data to produce a simulated hydrologic response. Climate data and data regarding point and nonpoint sources were used as input to WinHSPF. Climate data measured in Valparaiso was used to drive the rainfall-runoff component of model. Quantification of point and nonpoint

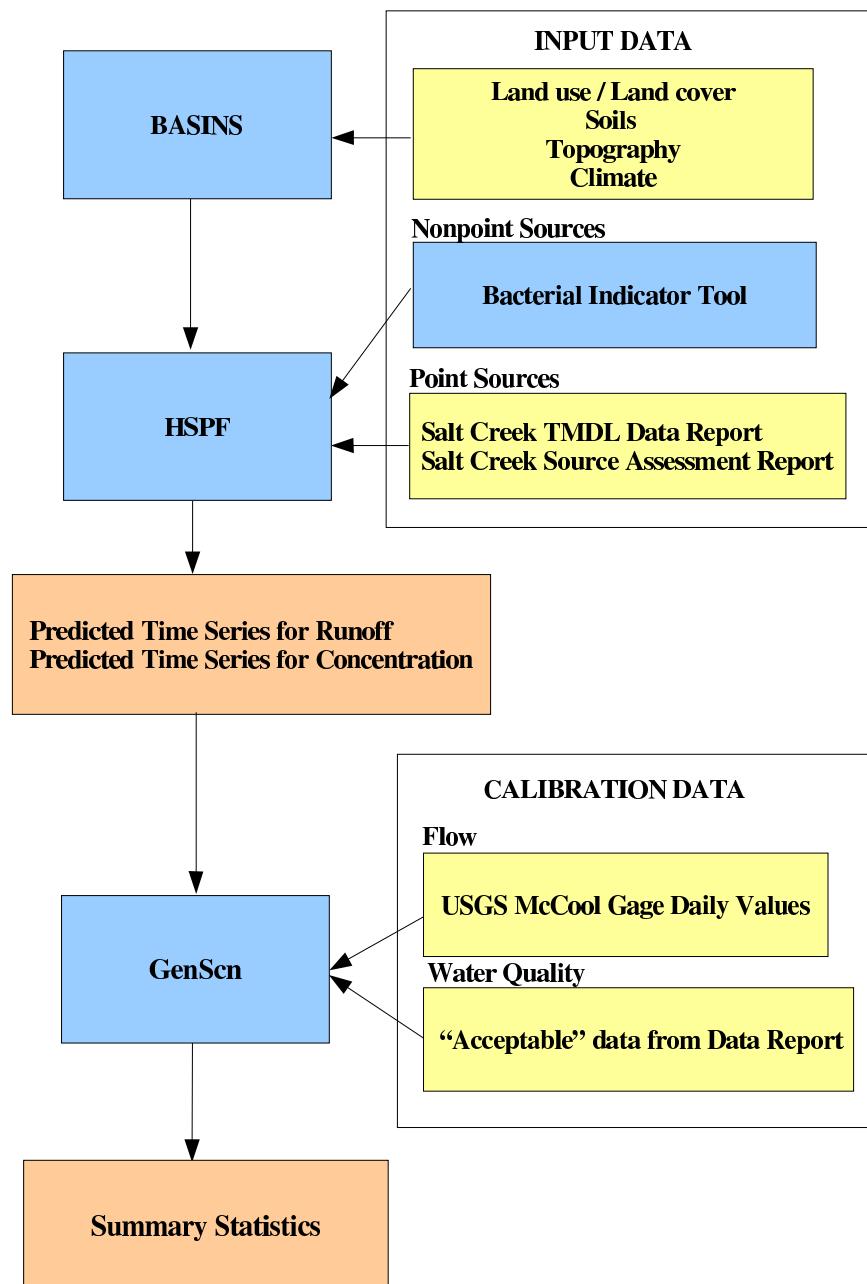


Figure 1: Software and data framework for the Salt Creek *E. coli* TMDL.

(blue=software; yellow=data; orange=output)



Figure 2: WinHSPF layout of Salt Creek watershed model.

source loads are presented in detail in the Salt Creek TMDL Source Assessment Report [WHPA, 2003c]. Point source loads were estimated from National Pollution Discharge Elimination System (NPDES) information. Nonpoint source loads were estimated with the Bacterial Indicator Tool for the Source Assessment. The Bacterial Indicator Tool, also distributed with BASINS 3.0, is a spreadsheet that estimates the bacteria contribution from multiple sources [U.S. EPA, 2000a]. The spreadsheet was produced for use with fecal coliform, but was developed with adaptation in mind. WHPA adapted the spreadsheet for use with *E. coli* by modifying production parameters. The worksheets estimate the loading rate from livestock, wildlife, and failing septic systems. In addition, output sheets estimate the accumulation rate and buildup limit of fecal waste on four different land uses (cropland, forest, built-up, and pastureland). Output from the spreadsheets can easily be used as input to WinHSPF and the HSPF watershed loading components.

Typical application of HSPF requires development of parameter values for a large number of physically-based algorithms. Initial parameterization of the model was aided by USEPA guidance [U.S. EPA, 2000b] and HSPFParm [U.S. EPA, 1999], a database of calibrated HSPF parameter values used in watersheds across the Nation. Calibrated parameter values from HSPFParm utilized in a small watershed in the Lake Region of Ohio were used to develop realistic starting values for the parameterization of the Salt Creek WinHSPF

model.

Included in the BASINS 3.0 package are various ancillary tools that enhance the analysis process (Figure 1). GenScn is a postprocessing tool utilized for managing timeseries data sets in WDM format. The WDM format was developed by the USGS and is used by WinHSPF for input and output timeseries data. GenScn facilitates the display and interpretation of output data and computes summary statistics for evaluating model performance. The approach for calibrating the flow and water quality components of the model are described below.

1.2 Calibration

Calibration establishes the model's ability to represent watershed processes. Calibration is an iterative procedure in which parameter values are adjusted and refined based on comparison of simulated and observed values. A robust calibration procedure should result in realistic parameter values that provide the best agreement between simulated and observed values. Model calibration and verification were based on methods described in Donigian [2002]. Donigian describes a “weight of evidence” approach that represents current practice in watershed model calibration and validation. The approach includes multiple tests and comparisons to evaluate model performance.

Model verification is an extension of the calibration effort. The purpose of validation is to demonstrate the ability of the model to predict observations for conditions different than the calibration period. This step is typically performed for calibration of flow. Model credibility depends on the ability of the model to represent the entire range of observed data with a single set of input parameters [Donigian, 2002]. In the validation process, the model is operated with the same unique set of input parameters formulated during the calibration process. The results are then compared to a subset of field observations not utilized during calibration. The same procedures used to assess model prediction for calibration are used for verification.

Calibration and verification of flow were accomplished by comparing simulated flows and flows observed at the U.S. Geological Survey stream gage in McCool, Indiana. Characteristics of the gage, including its location and statistics generated from the streamflow data are presented in the Salt Creek Data Report [WHPA, 2003a]. The site of the gage is located at the mouth of the Salt Creek watershed, just upstream of the creek's confluence with the Little Calumet River. Unfortunately, the McCool gage was retired on September 30, 1991. The lack of recent flow data meant that the hydrologic and water-quality components of the model were calibrated with data with different periods of record. However, it was considered imperative to use data from the watershed to the extent possible.

Flow was calibrated with data from water years 1988-1990 and verified with data from water year 1991. The water year begins October 1 and ends September 30. The water year was used as the annual “accounting unit” for calibration rather than the calendar year so that the partial record of McCool gage data in 1991 could be fully utilized.

Calibration was achieved with the hierarchical approach described by Donigian [2002] and by the HSPF application guide [U.S. EPA, 1984]. The hydrologic calibration preceded calibration of water-quality constituents. General hydrology was calibrated first, followed by nonpoint source loading rates and bacteria dynamics. The hydrologic calibration was accomplished by addressing, in order, four watershed characteristics: 1.) annual water balance, 2.) seasonal and monthly flows, 3.) baseflow, and 4.) storm events. Calibration of each hydrologic characteristic involved methodically adjusting the input parameters [A.S. Donigian, 1984, Donigian, 2002] and then evaluating model performance. A USEPA technical document provided additional guidance on realistic parameter ranges [U.S. EPA, 2000b]. Calibration was considered done when: 1.) all four hydrologic aspects were addressed, 2.) model performance criteria were acceptable based on criteria outlined by Donigian [2002], and 3.) further improvement in model performance criteria was seen as limited by uncertainties in input and calibration data.

A baseflow separation program was used to estimate characteristics of the ground water flow component in the watershed. The program is described in Arnold and others [1995] and Arnold and others [1999]. Daily values from the period of record at the McCool gage were used as input. The estimated ground water contribution was considered in the first three watershed characteristics addressed in the hydrologic calibration.

Model performance for flow was evaluated by comparing observed and simulated values with graphical and statistical means. Comparisons of simulated and observed flows were performed during the calibration and verification periods for annual, monthly, and daily values. Graphical methods of evaluation included timeseries and scatterplot comparisons of simulated and observed values for flow. Graphical comparisons also included comparison of flow-duration curves based on simulated and observed data. Numerical and statistical means used for evaluation of model performance include mean error, percent mean error, correlation coefficient (R), coefficient of determination (R^2), and Nash Sutcliffe simulation efficiency. The R^2 value is an indicator of the strength of the relationship between the observed and simulated values. The Nash-Sutcliffe simulation efficiency indicates how well the observed and simulated values fit a 1:1 relationship. Values near 1 for R , R^2 , and Nash-Sutcliffe simulation efficiency indicate a good fit of the data, whereas values near 0 indicate a poor fit of the data.

Concentrations of *E. coli* were modeled as a flow-associated constituent. This technique is standard practice for modeling bacteria. Water-quality data sets that were deemed acceptable for use in this project are presented in the Salt Creek Data Report [WHPA, 2003a]. Data collected in 1998 by the Point Source Committee of the Interagency Task Force were used for calibration of simulated *E. coli* concentrations. This subset of the available data was selected for calibration for two main reasons: 1.) the in-stream samples were collected weekly at multiple locations throughout the entire recreational season, and 2.) Combined Sewer Overflow (CSO) volumes from Valparaiso were also recorded. The weekly sampling frequency provided the best opportunity for evaluating a range of conditions in the watershed throughout an entire recreational

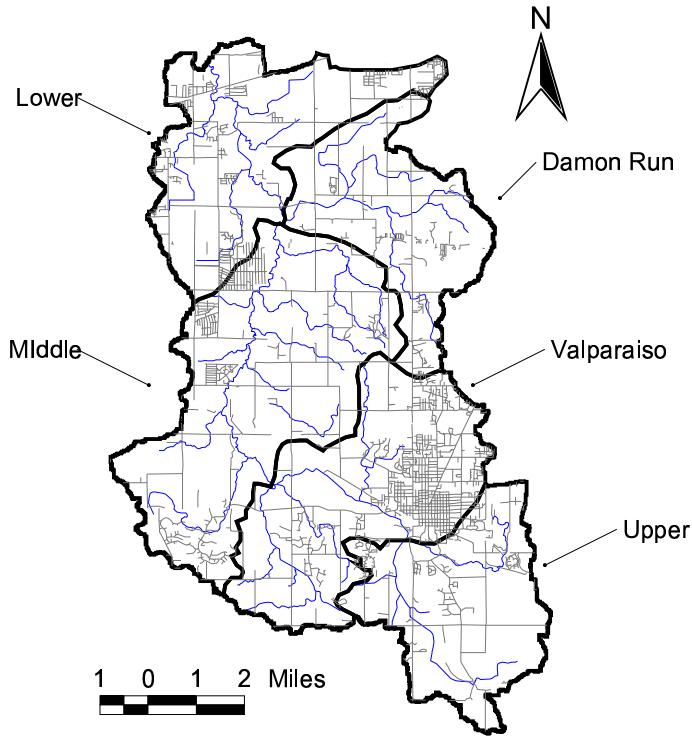


Figure 3: Salt Creek subwatershed delineations used for nonpoint source loading estimates.

season. The Data Report and the Source Assessment [WHPA, 2003c] identified the CSO as an important source of *E. coli* in the watershed. The accompanying CSO data allowed realistic estimates of inputs from that source. The only other existing data regarding CSO volumes in the recreational season are from 2002, for which there is no accompanying water-quality data sets for calibration.

Initial model inputs representing nonpoint and point-source loads were estimated from data compiled for the Data Report [WHPA, 2003b] and the Source Assessment Report [WHPA, 2003c]. To estimate nonpoint source loads with the Bacterial Indicator Tool, the watershed was divided into five subwatersheds (Figure 3) as described in the Source Assessment Report. The in-stream decay rate was estimated from data presented in U.S. EPA [2001]. A temperature correction coefficient was used for the first order decay. The in-stream temperature was estimated from monthly measurements collected by IDEM at two Fixed Station sites in the watershed [WHPA, 2003a].

Calibration of the water-quality component of the model was achieved by following general guidelines presented in Donigian [2002] and the HSPF Application Guide [U.S. EPA, 1984]. Calibration was accomplished in a stepwise fashion; the model components were addressed in the following order: 1.) Nonpoint

source loading rates, 2.) In-stream parameters, and 3.) Point source loading estimates. Input parameters effecting each model component were adjusted to obtain good agreement between observed and simulated concentrations. Results were evaluated based on graphical methods.

2 HYDROLOGIC CALIBRATION AND VERIFICATION

Calibration of the hydrologic component of the Salt Creek watershed model was a stepwise process as described in the Approach. The four watershed characteristics were addressed sequentially. Each step involved an iterative process of executing the model, interpreting the results as described in the Approach, and adjusting input parameters accordingly. All final, calibrated input parameters were within the published, possible ranges [U.S. EPA, 2000b]. Table 2 presents a comparison of the annual flows observed at the McCool gage with the corresponding annual flows predicted by the calibrated model. The mean annual discharge at the gage from 1947 to 1990 was 14.0 inches. The average annual flow for the calibration period was 15.0 inches. Flow data from 1991 was ideal for the verification period because 1991 was a wetter than average year. The average annual flow for 1991 was 19.3 inches. Calibration with data from a wet year provided the opportunity to evaluate the model under conditions different than the calibration period.

Comparison of observed and simulated values for annual flow and baseflow contribution from the calibrated model were acceptable. Donigian [2002] considers percent mean errors of less than ten percent to be “very good” for monthly and annual flows. The differences between the simulated and observed annual flows were less than ten percent for the calibration and verification periods (Table 2). The annual baseflow component at the McCool gage was estimated to be about 50%, based on 45 complete years of record. The simulated baseflow contribution for the calibration years averaged 52% (Table 2). The simulated baseflow contribution for the verification period was 54%, somewhat lower than the average for the period of record. A lower portion of baseflow contribution is expected in a wetter year.

Table 3 presents statistical results for monthly and daily flows predicted by the calibrated model. The results for the calibration and verification periods show good agreement based on monthly and daily comparisons. The correlation coefficients for the monthly and daily values for the calibration period indicate that the results are “good” as described by Donigian [2002]. By the same standards, results from the verification period indicate that the predictive capacity of the model is “good” for daily flows and categorized as “very good” for monthly flows.

Graphical comparisons of output were also employed to add weight to the evaluation of model performance. Figure 5 shows the scatterplots of observed and predicted daily flows at McCool. The scatterplots for the daily calibration and verification results both show graphically the correlation features of the results. Figure 6 shows observed and predicted flow-duration curves at the same site. The flow-duration curves for both calibration and verification show reasonable representation of the flow distribution. Figure 7 shows

a timeseries plot of simulated and observed flows at McCool. Simulated daily flows matched well with observed flows. Some difficulties were encountered in matching exactly the magnitude or timing of storm events. In many cases, the model simulates small storm events that are not reflected in the observed data. Difficulties in matching exactly the timing or magnitude of storm flows can largely be attributed to spatial and temporal uncertainties in the input climate data. Inherent approximations are introduced by using data from only one climate site to represent the entire watershed. There are numerous additional uncertainties in the measured input data and data used for calibration, including: 1.) spatial variability errors in soils and land use data, 2.) errors in flow measurements, and 3.) errors caused by sampling strategies.

3 WATER QUALITY CALIBRATION

As described in the Approach, calibration of simulated *E. coli* concentrations was accomplished by first addressing nonpoint source loads. Parameters governing nonpoint source loading rates were adjusted based on comparison of simulated and observed values in Upper Salt Creek. This portion of the watershed has no known point sources, a mixture of land use, and afforded comparison with in-stream water quality data collected by the Point Source Committee of the Interagency Task Force (Site 201, Figure 4). Input parameters that were calibrated include the monthly accumulation rates (MON-ACCUM) and storage limit (SQOLIM) for each subwatershed/landuse combination. The washoff coefficient (WSQOP), which relates runoff intensity to pollutant washoff, was also adjusted. Final calibrated values for the monthly accumulation rates are shown in Table 4. Calibrated values for the storage limit are shown in Table 5. Final values for the washoff coefficient were 0.3 in/hr for Forest and Agricultural land use and 0.1 in/hr for Pasture and Urban land use.

Calibration of the in-stream decay rate and point source loading rates were accomplished by comparing simulated and observed *E. coli* concentrations at the watershed outlet (Site 208, Figure 4). The decay rate (FSTDEC) was adjusted to a final value of 0.4 day^{-1} for all reaches. A value of 1.1 was used as the temperature correction coefficient for first order decay (THFST). Estimated point source loads were adjusted for the final calibration. The final point source loading rates are shown in Table 6. The final calibration for the watershed outlet (Figure 8) provides a good fit to the measured data. The model appears to overpredict the peaks caused by CSO inputs. However, the limited spatial scale and quantification limits of the observed data imposes limits on any comparison with predicted values. The input file for the calibrated WinHSPF model is provided in Attachment A.

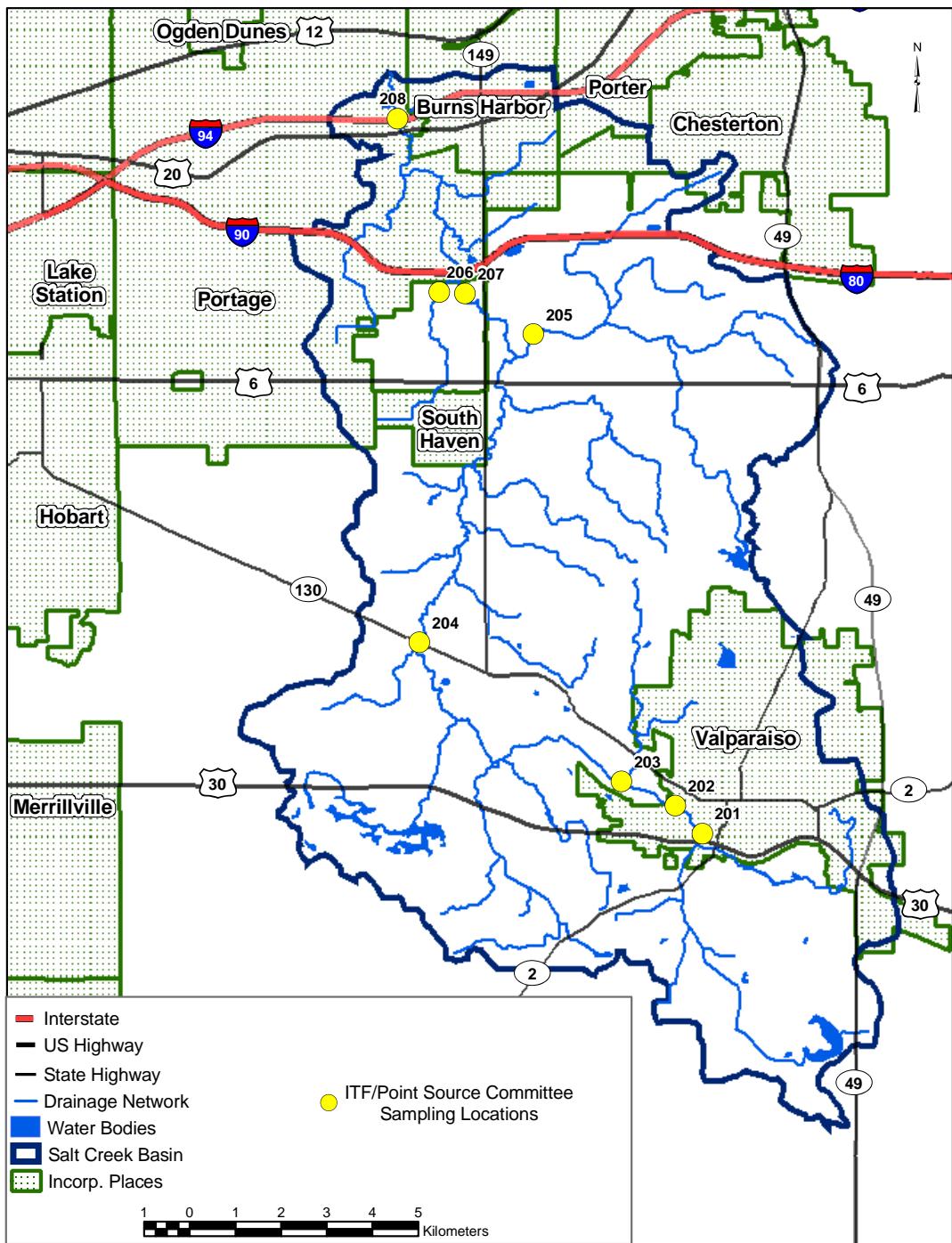


Figure 4: Locations of sites in the Salt Creek basin sampled for the Lake Michigan Interagency Task Force/Point Source Committee.

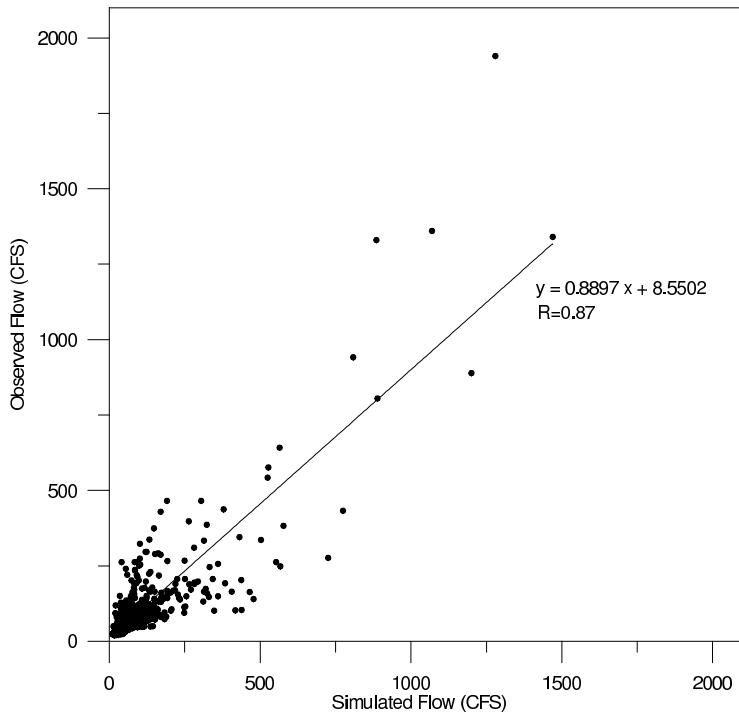
Table 2: Comparison of simulated and observed annual flow at McCool Gage for calibration and verification period.

Water Year	Simulated Baseflow (%)	Simulated Flow (inches)	Observed Flow (inches)	Residual (Sim-Obs)	Error (%)
Calibration Period					
1988	59	11.5	12.1	-0.6	-5.2
1989	50	16.3	15.2	1.1	6.7
1990	46	17.0	17	0	0
Average	52	15.0	14.8	0.2	1.3
Validation Period					
1991	54	21.6	19.3	1.3	6.0

Table 3: Summary statistics from flow calibration and verification.

		Correlation Coefficient, R	Coefficient of Determination, R ²	NS Model Fit Efficiency
Calibration: Water Years 1988-1990	Average Monthly	0.91	0.83	0.83
	Average Daily	0.87	0.76	0.76
Verification: Water Year 1991	Average Monthly	0.93	0.86	0.80
	Average Daily	0.80	0.63	0.63

NS= *Nash-Sutcliffe*



(a) Daily flow for the calibration period at McCool.

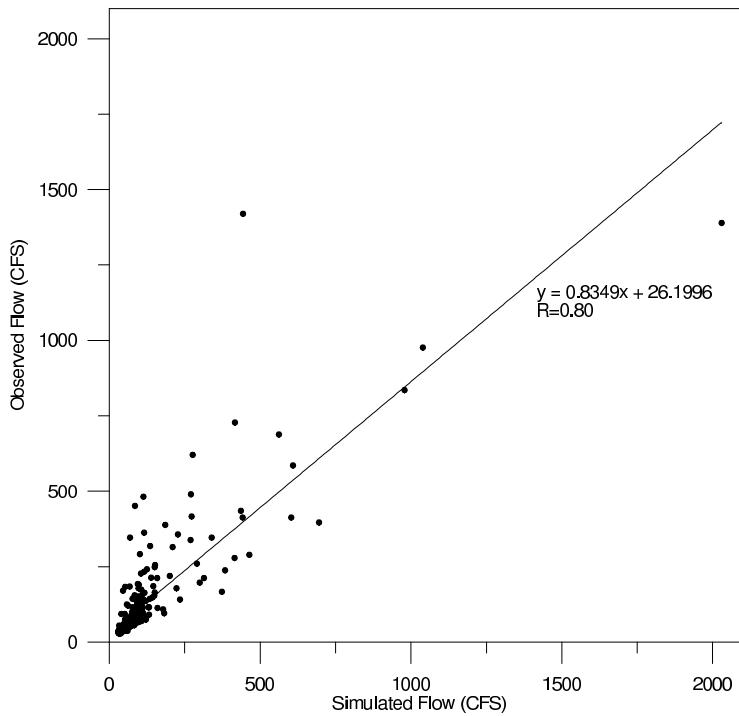
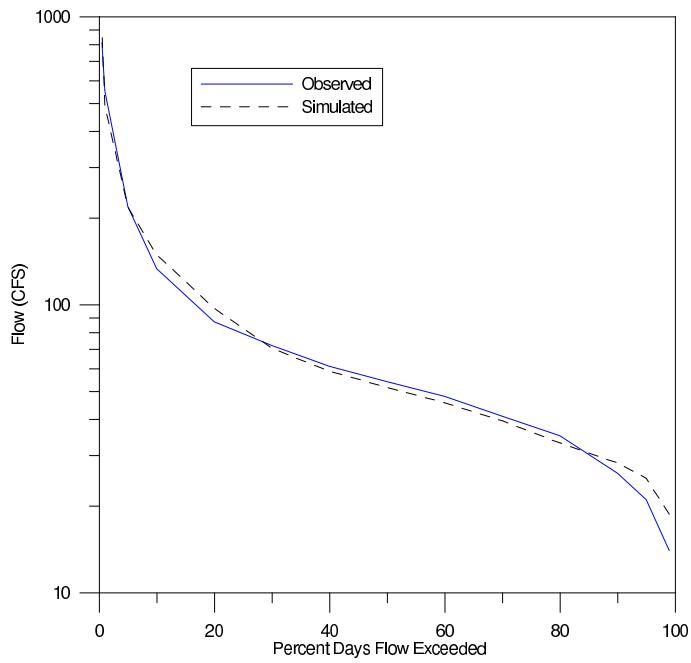
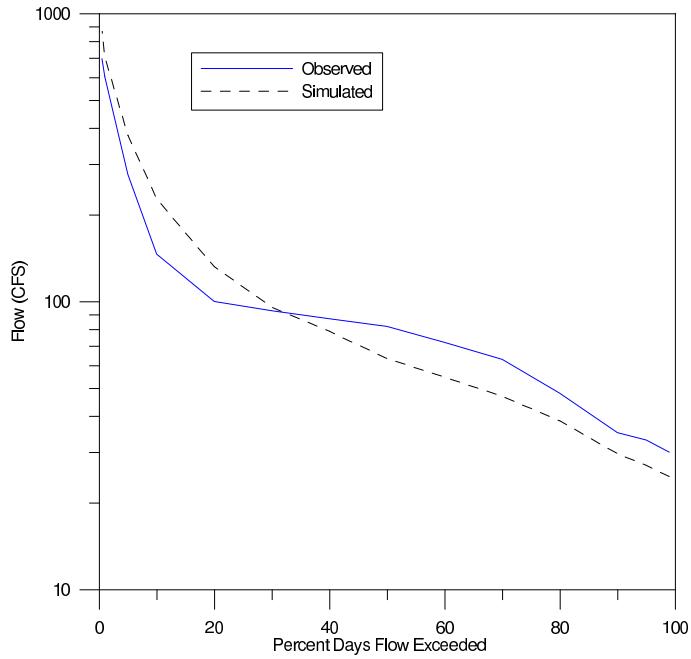


Figure 5: Scatterplots of observed and simulated daily flow in Salt Creek at McCool.



(a) Flow-duration curve for calibration period at McCool.



(b) Flow-duration curve for the validation period at McCool.

Figure 6: Observed and simulated flow-duration curves for Salt Creek at McCool: Calibration and validation periods.

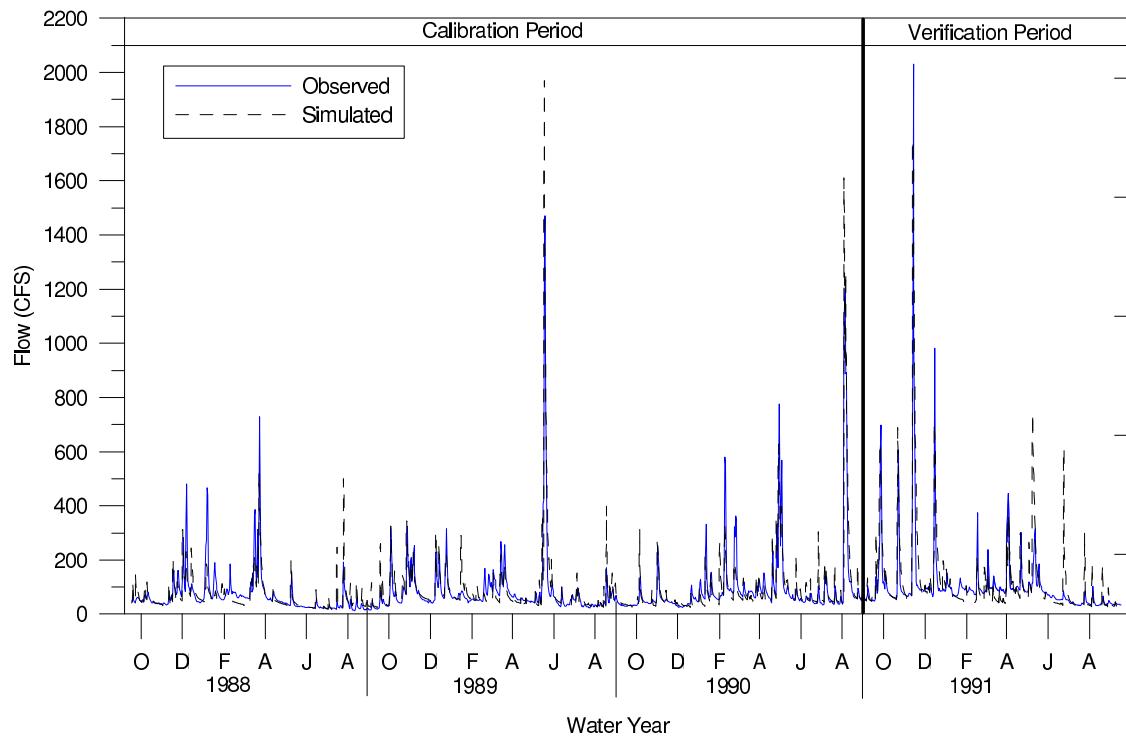


Figure 7: Observed and simulated daily flows in Salt Creek at McCool for the calibration and verification periods

Table 4: Final monthly accumulation rates for each subwatershed/land-use combination (counts/acre-day).

Subwatershed	Land Use	January	February	March	April	May	June	July	August	September	October	November	December
Upper	Forest	1.30E+09	1.30E+09	1.30E+09	1.30E+09								
	Pasture	4.40E+09	4.40E+09	4.40E+09	4.40E+09	4.40E+09	4.30E+09	4.30E+09	4.30E+09	4.30E+09	4.40E+09	4.40E+09	4.40E+09
	Agriculture	1.30E+09	1.30E+09	1.80E+09	1.80E+09	1.80E+09	1.30E+09	1.30E+09	1.30E+09	1.30E+09	1.80E+09	1.80E+09	1.30E+09
	Urban	2.00E+06	2.00E+06	2.00E+06	2.00E+06								
	Impervious	1.00E+08	1.00E+08	1.00E+08	1.00E+08								
Valparaiso	Forest	1.30E+09	1.30E+09	1.30E+09	1.30E+09								
	Pasture	2.60E+09	2.60E+09	2.60E+09	2.90E+09	2.90E+09	2.60E+09	2.60E+09	2.60E+09	2.60E+09	2.90E+09	2.90E+09	2.60E+09
	Agriculture	1.30E+09	1.30E+09	1.40E+09	1.40E+09	1.40E+09	1.30E+09	1.30E+09	1.30E+09	1.30E+09	1.40E+09	1.40E+09	1.30E+09
	Urban	2.00E+06	2.00E+06	2.00E+06	2.00E+06								
	Impervious	1.00E+08	1.00E+08	1.00E+08	1.00E+08								
Middle	Forest	1.30E+09	1.30E+09	1.30E+09	1.30E+09								
	Pasture	6.50E+09	6.50E+09	6.50E+09	6.50E+09	6.50E+09	6.30E+09	6.30E+09	6.30E+09	6.30E+09	6.50E+09	6.50E+09	6.50E+09
	Agriculture	1.30E+09	1.30E+09	1.30E+09	1.30E+09								
	Urban	2.00E+06	2.00E+06	2.00E+06	2.00E+06								
	Impervious	1.00E+08	1.00E+08	1.00E+08	1.00E+08								
Damon	Forest	1.30E+09	1.30E+09	1.30E+09	1.30E+09								
	Pasture	7.80E+09	7.80E+09	7.80E+09	8.20E+09	8.10E+09	7.60E+09	7.60E+09	7.60E+09	7.60E+09	8.10E+09	8.20E+09	7.80E+09
	Agriculture	1.30E+09	1.30E+09	6.70E+09	7.00E+08	6.70E+09	1.30E+09	1.30E+09	1.30E+09	1.30E+09	6.70E+09	7.00E+08	1.30E+09
	Urban	2.00E+06	2.00E+06	2.00E+06	2.00E+06								
	Impervious	1.00E+08	1.00E+08	1.00E+08	1.00E+08								
Lower	Forest	1.30E+09	1.30E+09	1.30E+09	1.30E+09								
	Pasture	2.60E+09	2.60E+09	2.60E+09	2.60E+09								
	Agriculture	1.30E+09	1.30E+09	2.00E+08	2.00E+08	2.00E+08	1.30E+09	1.30E+09	1.30E+09	1.30E+09	2.00E+08	2.00E+08	1.30E+09
	Urban	2.00E+06	2.00E+06	2.00E+06	2.00E+06								
	Impervious	1.00E+08	1.00E+08	1.00E+08	1.00E+08								

Table 5: Final storage limits for each subwatershed/land-use combination (count.acre).

Subwatershed	Land Use	January	February	March	April	May	June	July	August	September	October	November	December
Upper	Forest	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10
	Pasture	8.E+10	8.E+10	8.E+10	7.E+10	7.E+10	7.E+10	7.E+10	7.E+10	7.E+10	8.E+10	8.E+10	8.E+10
	Agriculture	3.E+10	3.E+10	4.E+10	3.E+10	3.E+10	2.E+10	2.E+10	2.E+10	2.E+10	4.E+10	4.E+10	3.E+10
	Urban	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07
	Impervious	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10
Valparaiso	Forest	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10
	Pasture	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	4.E+10	4.E+10	4.E+10	4.E+10	6.E+10	6.E+10	6.E+10
	Agriculture	3.E+10	3.E+10	3.E+10	2.E+10	2.E+10	2.E+10	2.E+10	2.E+10	2.E+10	3.E+10	3.E+10	3.E+10
	Urban	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07
	Impervious	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10
Middle	Forest	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10
	Pasture	3.E+11	3.E+11	3.E+11	1.E+10	1.E+10	1.E+10	1.E+10	1.E+10	1.E+10	3.E+11	3.E+11	3.E+11
	Agriculture	3.E+10	3.E+10	4.E+10	3.E+10	3.E+10	2.E+10	2.E+10	2.E+10	2.E+10	4.E+10	4.E+10	3.E+10
	Urban	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07
	Impervious	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10
Damon	Forest	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10
	Pasture	3.E+11	3.E+11	3.E+11	3.E+11	3.E+11	3.E+11	3.E+11	3.E+11	3.E+11	3.E+11	3.E+11	3.E+11
	Agriculture	3.E+10	3.E+10	3.E+11	3.E+11	3.E+11	2.E+10	2.E+10	2.E+10	2.E+10	3.E+11	3.E+11	3.E+10
	Urban	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07
	Impervious	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10
Lower	Forest	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10	3.E+10
	Pasture	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	4.E+10	4.E+10	4.E+10	4.E+10	5.E+10	5.E+10	5.E+10
	Agriculture	3.E+10	3.E+10	3.E+10	3.E+10	2.E+10	2.E+10	2.E+10	2.E+10	2.E+10	3.E+10	3.E+10	3.E+10
	Urban	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07	4.E+07
	Impervious	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10	5.E+10

Table 6: Final estimated loads used as input in calibrated model.

SOURCE CATEGORY		DAILY LOAD (counts/day)
In-stream Cattle and Septic	Subwatershed	
	Damon Run	3.08E+10
	Lower	1.28E+10
	Middle	3.82E+10
	Upper	3.59E+10
	Valpo	3.73E+10
NPDES	Facility	
	Liberty Schools	4.19E+09
	Shorewood Forest	1.13E+08
	Sands Mobile Home Park	3.12E+08
	Liberty Farm Mobile Home Park	2.44E+08
	Burns Harbor Estates	2.28E+08
	Elmwood Mobile Home Park	6.27E+08
	Nature Works Conservancy District	3.01E+08
	Mallard's Pointe Condominiums	9.75E+07
	Valparaiso Municipal STP	1.49E+09
	South Haven Sewer Works	7.40E+07
	Month	
Valparaiso Municipal STP By-Pass	01/98	9.16E+10
	02/98	6.90E+09
	03/98	2.79E+10
	04/98	2.17E+10
	05/98	2.08E+10
	06/98	2.81E+10
	07/98	5.80E+10
	08/98	1.06E+09
	09/98	3.07E+09
	10/98	0.00E+00
	Day	
Valparaiso Municipal STP CSO	04/13/98	5.35E+13
	04/21/98	6.40E+12
	05/07/98	4.00E+13
	05/08/98	1.06E+13
	06/11/98	3.95E+13
	07/03/98	8.87E+12
	07/04/98	1.06E+13
	07/17/98	6.47E+13
	08/14/98	6.43E+13
	09/20/98	4.52E+12

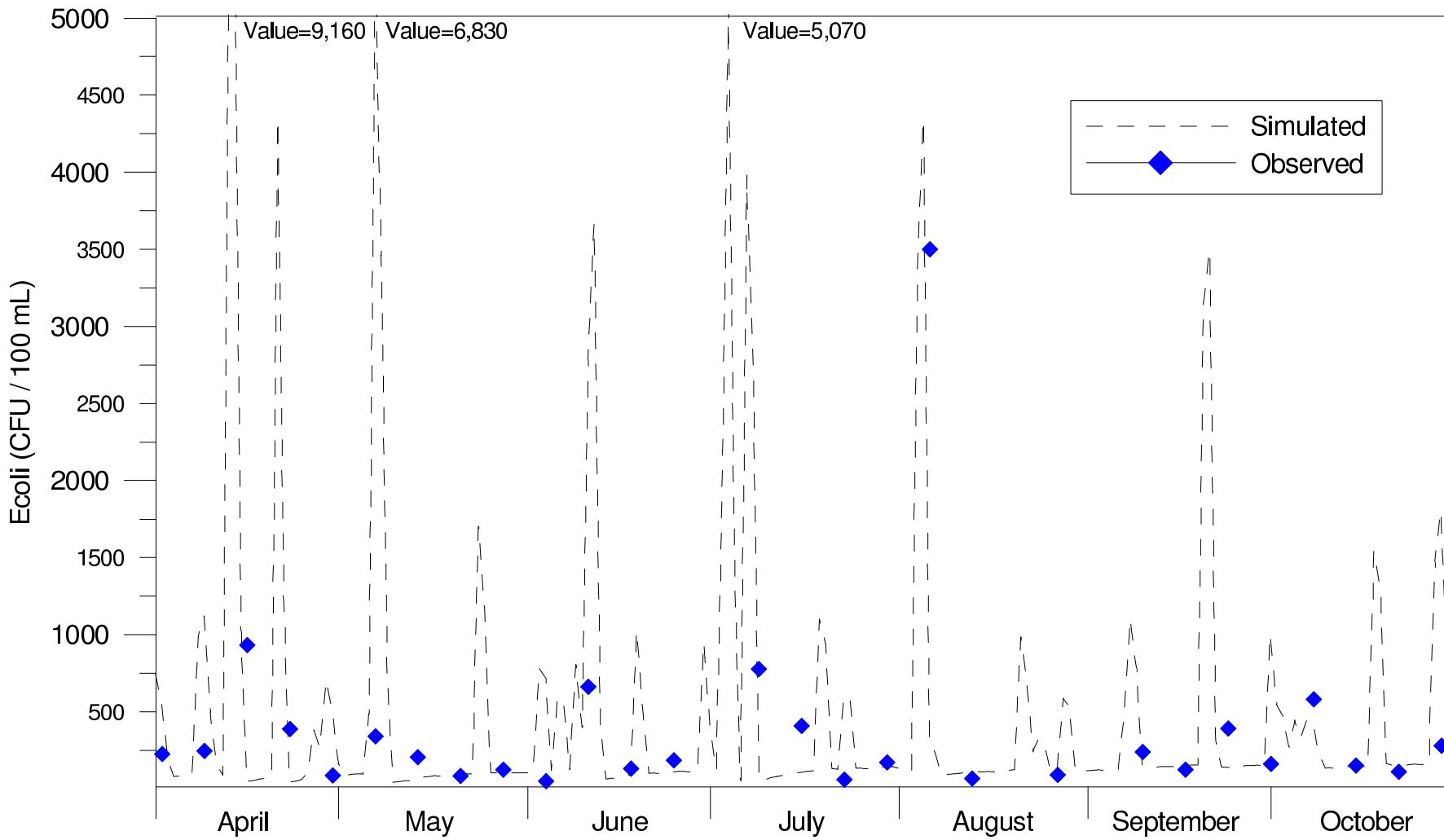


Figure 8: Observed and simulated daily concentration in Salt Creek at watershed outlet for the 1998 recreational season.

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Attachment A Input File for Calibrated WinHSPF Model

RUN

GLOBAL

UCI Created by WinHSPF for salt1
START 1995/10/01 00:00 END 2001/10/31 24:00
RUN INTERP OUTPT LEVELS 1 0
RESUME 0 RUN 1 UNITS 1
END GLOBAL

FILES

<FILE> <UN#>***<----FILE NAME----->
MESSU 24 wq44.WQ1.ech
91 wq44.WQ1.out
WDM1 25 ..\saltout2.wdm
WDM2 26 ..\..\data\met_data\valpo.wdm
END FILES

OPN SEQUENCE

INGRP INDELT 01:00

PERLND 101
PERLND 102
PERLND 103
PERLND 104
PERLND 105
IMPLND 101
PERLND 106
PERLND 107
PERLND 108
PERLND 109
PERLND 110
IMPLND 102
PERLND 111
PERLND 112
PERLND 113
PERLND 114
PERLND 115
IMPLND 103
PERLND 116
PERLND 117
PERLND 118
PERLND 119
PERLND 120
IMPLND 104
PERLND 121
PERLND 122
PERLND 123
PERLND 124
PERLND 125
IMPLND 105
RCHRES 5
RCHRES 2
RCHRES 11
RCHRES 6
RCHRES 7
RCHRES 18
RCHRES 8
RCHRES 9
RCHRES 20
RCHRES 12
RCHRES 21
RCHRES 3
RCHRES 24
RCHRES 16
RCHRES 10
RCHRES 14
RCHRES 28

```

RCHRES      25
RCHRES      30
RCHRES      29
RCHRES      34
RCHRES      26
RCHRES      27
RCHRES      35
RCHRES      23
RCHRES      22
RCHRES      33
RCHRES      19
RCHRES      17
RCHRES      15
RCHRES      36
RCHRES      13
RCHRES      4
RCHRES      1
RCHRES      31
RCHRES      32
COPY        1
COPY        2
END INGRP
END OPN SEQUENCE

PERLND
ACTIVITY
*** <PLS >          Active Sections           ***
*** x - x ATMP SNOW PWAT SED PST PWG PQAL MSTL PEST NITR PHOS TRAC ***
101 125   0   0   1   0   0   0   1   0   0   0   0   0   0   0
END ACTIVITY

PRINT-INFO
*** < PLS>          Print-flags           PIVL PYR
*** x - x ATMP SNOW PWAT SED PST PWG PQAL MSTL PEST NITR PHOS TRAC
101 125   4   4   4   4   4   4   4   4   4   4   4   4   4   1   9
END PRINT-INFO

GEN-INFO
***          Name          Unit-systems     Printer BinaryOut
*** <PLS >          t-series       Engl Metr Engl Metr
*** x - x
          in    out
101    Forest Land      1    1    0    0    0    0
102    Pasture          1    1    0    0    0    0
103    Agricultural Land 1    1    0    0    0    0
104    Water             1    1    0    0    0    0
105    Urban or Built-up La 1    1    0    0    0    0
106    Forest Land      1    1    0    0    0    0
107    Pasture          1    1    0    0    0    0
108    Agricultural Land 1    1    0    0    0    0
109    Water             1    1    0    0    0    0
110    Urban or Built-up La 1    1    0    0    0    0
111    Forest Land      1    1    0    0    0    0
112    Pasture          1    1    0    0    0    0
113    Agricultural Land 1    1    0    0    0    0
114    Water             1    1    0    0    0    0
115    Urban or Built-up La 1    1    0    0    0    0
116    Forest Land      1    1    0    0    0    0
117    Pasture          1    1    0    0    0    0
118    Agricultural Land 1    1    0    0    0    0
119    Water             1    1    0    0    0    0
120    Urban or Built-up La 1    1    0    0    0    0
121    Forest Land      1    1    0    0    0    0
122    Pasture          1    1    0    0    0    0
123    Agricultural Land 1    1    0    0    0    0
124    Water             1    1    0    0    0    0
125    Urban or Built-up La 1    1    0    0    0    0

```

END GEN-INFO

ATEMP-DAT
*** <PLS > ELDAT AIRTEMP
*** x - x (ft) (deg F)
101 125 -50. 60.
END ATEMP-DAT

ICE-FLAG
*** <PLS > Ice-
*** x - x flag
101 125 1
END ICE-FLAG

SNOW-FLAGS
*** <PLS >
*** x - x SNOP VKM
101 125 1 0
END SNOW-FLAGS

SNOW-PARM1
*** < PLS> LAT MELEV SHADE SNOWCF COVIND KMELT TBASE
*** x - x degrees (ft) (in) (in/d.F) (F)
101 125 41.5 700. 0.05 1.2 0.5 0.
END SNOW-PARM1

SNOW-PARM2
*** <PLS > RDCSN TSNOW SNOEVP CCFACT MWATER MGMELT
*** x - x (deg F) (deg F) (in/day)
101 125 0.14 32. 0.05 1. 0.03 0.01
END SNOW-PARM2

SNOW-INIT1
*** <PLS > Pack-snow Pack-ice Pack-watr RDENPF DULL PAKTMP
*** x - x (in) (in) (in) (deg F)
101 125 0. 0. 0. 0.01 0. 32.
END SNOW-INIT1

SNOW-INIT2
*** <PLS > COVINX XLNMLT SKYCLR
*** x - x (in) (in)
101 125 0.01 0. 0.5
END SNOW-INIT2

PWAT-PARM1
*** <PLS > Flags
*** x - x CSNO RTOP UZFG VCS VUZ VNN VIFW VIRG VLE IFFC HWT IRRG
101 125 0 1 1 0 0 0 0 0 1 1 0 0
END PWAT-PARM1

PWAT-PARM2
*** < PLS> FOREST LZSN INFILT LSUR SLSUR KVARY AGWRC
*** x - x (in) (in/hr) (ft) (1/in) (1/day)
101 0.3 10. 0.15 400. 0.146 0. 0.98
102 103 0.3 9. 0.15 400. 0.146 0. 0.98
104 105 0.3 9. 0.15 150. 0.1587 0. 0.98
106 0.3 10. 0.15 400. 0.146 0. 0.98
107 108 0.3 9. 0.15 400. 0.146 0. 0.98
109 110 0.3 9. 0.15 150. 0.1587 0. 0.98
111 0.3 10. 0.15 400. 0.146 0. 0.98
112 113 0.3 9. 0.15 400. 0.146 0. 0.98
114 115 0.3 9. 0.15 150. 0.1587 0. 0.98
116 0.3 10. 0.15 400. 0.146 0. 0.98
117 118 0.3 9. 0.15 400. 0.146 0. 0.98
119 120 0.3 9. 0.15 150. 0.1587 0. 0.98
121 0.3 10. 0.15 400. 0.146 0. 0.98

```

122 123      0.3      9.      0.15     400.      0.146      0.      0.98
124 125      0.3      9.      0.15     150.      0.1587     0.      0.98
END PWAT-PARM2

```

[View Details](#)

PWAT-PARM3

```

*** < PLS>      PETMAX      PETMIN      INFEXP      INFILD      DEEPFR      BASETP      AGWETP
*** x - x (deg F) (deg F)
  101  125       35.        30.         2.          2.          0.45         0.          0.
END PWAT-PARM3

```

PWAT-PARM4

*** <PLS >	CEPSC (in)	UZSN (in)	NSUR	INTFW	IRC (1/day)	LZETP
*** x - x						
101	0.1	1.	0.35	8.	0.7	0.6
102	0.1	0.7	0.1	7.	0.7	0.1
103	0.1	0.7	0.1	8.	0.7	0.5
104	0.1	0.7	0.05	8.	0.7	0.
105	0.1	0.7	0.1	7.	0.7	0.
106	0.1	1.	0.35	8.	0.7	0.6
107	0.1	0.7	0.1	7.	0.7	0.1
108	0.1	0.7	0.1	8.	0.7	0.5
109	0.1	0.7	0.05	8.	0.7	0.
110	0.1	0.7	0.1	7.	0.7	0.
111	0.1	1.	0.35	8.	0.7	0.6
112	0.1	0.7	0.1	7.	0.7	0.1
113	0.1	0.7	0.1	8.	0.7	0.5
114	0.1	0.7	0.05	7.	0.7	0.
115	0.1	0.7	0.1	7.	0.7	0.
116	0.1	1.	0.35	8.	0.7	0.6
117	0.1	0.7	0.1	7.	0.7	0.1
118	0.1	0.7	0.1	8.	0.7	0.5
119	0.1	0.7	0.05	7.	0.7	0.
120	0.1	0.7	0.1	7.	0.7	0.
121	0.1	1.	0.35	8.	0.7	0.6
122	0.1	0.7	0.1	7.	0.7	0.1
123	0.1	0.7	0.1	8.	0.7	0.5
124	0.1	0.7	0.05	7.	0.7	0.
125	0.1	0.7	0.1	7.	0.7	0.

END PWAT-PARM4

PWAT-STATE1

```
*** < PLS> PWATER state variables (in)
*** x - x      CEPS      SURS      UZS      IFWS      LZS      AGWS      GWVS
 101 125    0.01     0.01     0.3     0.01     1.5     0.01     0.01
END PWAT STATE1
```

MONITORING

MON-INTERCEP

*** <PLS > Interception storage capacity at start of each month (in)

	x - x	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
101		0.06	0.06	0.06	0.06	0.01	0.2	0.2	0.2	0.2	0.15	0.1	0.06
102	104	0.04	0.04	0.04	0.02	0.1	0.2	0.2	0.2	0.2	0.15	0.06	0.04
105		0.03	0.03	0.03	0.03	0.03	0.1	0.1	0.1	0.1	0.03	0.03	0.03
106		0.06	0.06	0.06	0.06	0.01	0.25	0.25	0.25	0.25	0.15	0.1	0.06
107	109	0.04	0.04	0.04	0.02	0.1	0.2	0.2	0.2	0.2	0.15	0.06	0.04
110		0.03	0.03	0.03	0.03	0.03	0.1	0.1	0.1	0.1	0.03	0.03	0.03
111		0.06	0.06	0.06	0.06	0.01	0.25	0.25	0.25	0.25	0.15	0.1	0.06
112	114	0.04	0.04	0.04	0.02	0.1	0.2	0.2	0.2	0.2	0.15	0.06	0.04
115		0.03	0.03	0.03	0.03	0.03	0.1	0.1	0.1	0.1	0.03	0.03	0.03
116		0.06	0.06	0.06	0.06	0.01	0.25	0.25	0.25	0.25	0.15	0.1	0.06
117	119	0.04	0.04	0.04	0.02	0.1	0.2	0.2	0.2	0.2	0.15	0.06	0.04
120		0.03	0.03	0.03	0.03	0.03	0.1	0.1	0.1	0.1	0.03	0.03	0.03
121		0.06	0.06	0.06	0.06	0.01	0.25	0.25	0.25	0.25	0.15	0.1	0.06
122	124	0.04	0.04	0.04	0.02	0.1	0.2	0.2	0.2	0.2	0.15	0.06	0.04
125		0.03	0.03	0.03	0.03	0.03	0.1	0.1	0.1	0.1	0.03	0.03	0.03

END MON-INTERCEP

MON-UZSN

*** <PLS > Upper zone storage at start of each month (inches)

*** x - x JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

	101	102	999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.
103	0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4
104	107-	999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.
108		0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4
109	112-	999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.
113		0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4
114	117-	999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.
118		0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4
119	122-	999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.
123		0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4
124	125-	999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.	-999.

END MON-UZSN

MON-LZETPARM

*** <PLS > Lower zone evapotransp parm at start of each month

*** x - x JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

	101	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
102	104	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.3	0.2
105		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
106		0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
107	109	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.3	0.2
110		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
111		0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
112	114	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.3	0.2
115		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
116		0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
117	119	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.3	0.2
120		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
121		0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
122	124	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.3	0.2
125		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

END MON-LZETPARM

NQUALS

*** <PLS >

*** x - xNQUAL

	101	125	1
--	-----	-----	---

END NQUALS

QUAL-PROPS

*** <PLS > Identifiers and Flags

*** x - x QUALID QTID QSD VPFW VPFS QSO VQO QIFW VIQC QAGW VAQC

	101	125F.COLIFORM	#ORG	0	0	0	1	1	0	0	0	0
--	-----	---------------	------	---	---	---	---	---	---	---	---	---

END QUAL-PROPS

QUAL-INPUT

*** Storage on surface and nonseasonal parameters

*** SQO POTFW POTFS ACQOP SQOLIM WSQOP IOQC AOQC

*** <PLS > qty/ac qty/ton qty/ton qty/ qty/ ac.day in/hr qty/ft³ qty/ft³

*** x - x

	101	100.	0.	0.	0.	1E+08	0.3	0.	0.
102	100.	0.	0.	0.	0.	1E+08	0.1	0.	0.
103	1000.	0.	0.	0.	0.	1E+08	0.3	0.	0.
104	100.	0.	0.	0.	0.	1E+08	0.01	0.	0.
105	500.	0.	0.	0.	0.	1E+08	0.1	0.	0.
106	100.	0.	0.	0.	0.	1E+08	0.3	0.	0.
107	100.	0.	0.	0.	0.	1E+08	0.1	0.	0.
108	1000.	0.	0.	0.	0.	1E+08	0.3	0.	0.
109	100.	0.	0.	0.	0.	1E+08	0.01	0.	0.
110	500.	0.	0.	0.	0.	1E+08	0.1	0.	0.
111	100.	0.	0.	0.	0.	1E+08	0.3	0.	0.
112	100.	0.	0.	0.	0.	1E+08	0.1	0.	0.
113	1000.	0.	0.	0.	0.	1E+08	0.3	0.	0.

MON-IFLW-CONC

MON-GRND-CONC

END PERLND

IMPLND

ACTIVITY

```
*** <ILS >                                Active Sections
*** x - x ATMP SNOW IWAT SLD IWG IQAL
    101 105   0    0    1    0    0    0    1
END ACTIVITY
```

```

PRINT-INFO
*** <ILS > ***** Print-flags ***** PIVL PYR
*** x - x ATMP SNOW IWAT SLD IWG IQAL *****
 101 105 4 4 4 4 4 1 9
END PRINT-INFO

GEN-INFO
*** Name Unit-systems Printer BinaryOut
*** <ILS > t-series Engl Metr Engl Metr
*** x - x in out
 101 105 Urban or Built-up La 1 1 0 0 0 0
END GEN-INFO

ATEMP-DAT
*** <ILS > ELDAT AIRTEMP
*** x - x (ft) (deg F)
 101 105 -50. 60.
END ATEMP-DAT

ICE-FLAG
*** <ILS > Ice-
*** x - x flag
 101 105 1
END ICE-FLAG

SNOW-FLAGS
*** <ILS >
*** x - x SNOP VKM
 101 105 1 0
END SNOW-FLAGS

SNOW-PARM1
*** < ILS> LAT MELEV SHADE SNOWCF COVIND KMELT TBASE
*** x - x degrees (ft) (in) (in/d.F) (F)
 101 105 40.5 700. 0.3 1.2 1. 0. 32.
END SNOW-PARM1

SNOW-PARM2
*** <ILS > RDMSN TSNOW SNOEVP CCFACT MWATER MGMELT
*** x - x (deg F) (deg F) (in/day)
 101 105 0.14 32. 0.05 1. 0.03 0.01
END SNOW-PARM2

MON-MELT-FAC
*** <ILS > Degree-day snowmelt factor at start of each month (in/d.F)
*** x - x JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
 101 105 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
END MON-MELT-FAC

SNOW-INIT1
*** <ILS > Pack-snow Pack-ice Pack-watr RDENPF DULL PAKTMP
*** x - x (in) (in) (in) (deg F)
 101 105 0. 0. 0. 0.01 0. 32.
END SNOW-INIT1

SNOW-INIT2
*** <ILS > COVINX XLNMLT SKYCLR
*** x - x (in) (in)
 101 105 0.01 0. 0.5
END SNOW-INIT2

IWAT-PARM1
*** <ILS > Flags
*** x - x CSNO RTOP VRS VNN RTLI
 101 105 0 0 0 0 0

```

```
END IWAT-PARM1
```

IWAT-PARM2

```
*** <ILS > LSUR SLSUR NSUR RETSC
*** x - x (ft) (in)
101 105 150. 0.1587 0.05 0.1
END IWAT-PARM2
```

IWAT-PARM3

```
*** <ILS > PETMAX PETMIN
*** x - x (deg F) (deg F)
101 105 40. 35.
END IWAT-PARM3
```

IWAT-STATE1

```
*** <ILS > IWATER state variables (inches)
*** x - x RETS SURS
101 105 0.01 0.01
END IWAT-STATE1
```

NQUALS

```
*** <ILS >
*** x - xNQUAL
101 105 1
END NQUALS
```

QUAL-PROPS

```
*** <ILS > Identifiers and Flags
*** x - x QUALID QTID QSD VPFW QSO VQO
101 105F.COLIFORM #ORG 0 0 1 0
END QUAL-PROPS
```

QUAL-INPUT

```
*** Storage on surface and nonseasonal parameters
*** SQO POTFW ACQOP SQOLIM WSQOP
*** <ILS > qty/ac qty/ton qty/ ac.day
*** x - x in/hr
101 105 6.2E+08 0. 1E+08 4.8E+10 0.1
END QUAL-INPUT
```

```
END IMPLND
```

RCHRES

ACTIVITY

```
*** RCHRES Active sections
*** x - x HYFG ADFG CNFG HTFG SDGF GQFG OXFG NUFG PKFG PHFG
1 36 1 1 0 0 0 1 0 0 0 0 0
END ACTIVITY
```

PRINT-INFO

```
*** RCHRES Printout level flags
*** x - x HYDR ADCA CONS HEAT SED GQL OXRX NUTR PLNK PHCB PIVL PYR
1 36 4 4 4 4 4 4 4 4 4 4 1 9
END PRINT-INFO
```

GEN-INFO

```
*** Name Nexits Unit Systems Printer
*** RCHRES t-series Engl Metr LKFG
*** x - x in out
1 36 1 1 91 0 0 0 0
END GEN-INFO
```

HYDR-PARM1

```
*** Flags for HYDR section
*** RC HRES VC A1 A2 A3 ODFVFG for each *** ODGTFG for each FUNCT for each
*** x - x FG FG FG FG possible exit *** possible exit possible exit
```

1 36 0 1 1 1 4 0 0 0 0 0 0 0 0 1 1 1 1 1
END HYDR-PARM1

HYDR-PARM2

*** RCHRES FTBW FTBU	LEN	DELTH	STCOR	KS	DB50
*** x - x	(miles)	(ft)	(ft)		(in)
1 0. 1.	1.59	38.	3.2	0.5	0.01
2 0. 2.	3.16	108.	3.2	0.5	0.01
3 0. 3.	0.65	48.	3.2	0.5	0.01
4 0. 4.	1.4	32.	3.2	0.5	0.01
5 0. 5.	0.78	48.	3.2	0.5	0.01
6 0. 6.	0.48	16.	3.2	0.5	0.01
7 0. 7.	0.46	30.	3.2	0.5	0.01
8 0. 8.	0.2	13.	3.2	0.5	0.01
9 0. 9.	0.28	22.	3.2	0.5	0.01
10 0. 10.	0.97	67.	3.2	0.5	0.01
11 0. 11.	0.89	32.	3.2	0.5	0.01
12 0. 12.	1.98	196.	3.2	0.5	0.01
13 0. 13.	0.12	0.	3.2	0.5	0.01
14 0. 14.	1.71	11.	3.2	0.5	0.01
15 0. 15.	1.37	16.	3.2	0.5	0.01
16 0. 16.	2.24	129.	3.2	0.5	0.01
17 0. 17.	1.53	38.	3.2	0.5	0.01
18 0. 18.	0.76	59.	3.2	0.5	0.01
19 0. 19.	1.2	43.	3.2	0.5	0.01
20 0. 20.	1.28	113.	3.2	0.5	0.01
21 0. 21.	1.21	112.	3.2	0.5	0.01
22 0. 22.	1.18	16.	3.2	0.5	0.01
23 0. 23.	0.75	26.	3.2	0.5	0.01
24 0. 24.	2.01	266.	3.2	0.5	0.01
25 0. 25.	2.25	259.	3.2	0.5	0.01
26 0. 26.	2.15	59.	3.2	0.5	0.01
27 0. 27.	1.36	62.	3.2	0.5	0.01
28 0. 28.	2.71	157.	3.2	0.5	0.01
29 0. 29.	5.27	95.	3.2	0.5	0.01
30 0. 30.	6.11	420.	3.2	0.5	0.01
31 0. 31.	1.12	27.	3.2	0.5	0.01
32 0. 32.	0.21	19.	3.2	0.5	0.01
33 0. 33.	0.21	25.	3.2	0.5	0.01
34 0. 34.	0.24	7.	3.2	0.5	0.01
35 0. 35.	0.27	13.	3.2	0.5	0.01
36 0. 36.	0.36	0.	3.2	0.5	0.01

END HYDR-PARM2

HYDR-INIT

***	Initial conditions for HYDR section					
***RC HRES	VOL	CAT	Initial value of COLIND	initial value of OUTDGT		
*** x - x	ac-ft	for each possible exit	for each possible exit,ft3			
1 36	0.01	4.2 4.5 4.5 4.5 4.2	2.1 1.2 0.5 1.2 1.8			

END HYDR-INIT

GQ-GENDATA

*** RCHRES NGQL TPFG PHFG ROFG CDFG SDFG PYFG	LAT
*** x - x	deg
1 36 1 3 2 2 2 2 2 0	

END GQ-GENDATA

GQ-QALDATA

*** RCHRES	GQID	DQAL	CONCID	CONV	QTYID
*** x - x		concid			
1 36ECOLI		50.	OR/L	0.0353	#ORG

GQ-QALFG

*** RCHRES HDRL OXID PHOT VOLT BIOD GEN SDAS
*** x - x

1 36 0 0 0 0 0 1 0
END GQ-QALFG

GQ-GENDECAY
*** RCHRES FSTDEC THFST
*** x - x (/day)
1 36 0.4 1.1
END GQ-GENDECAY

MON-WATEMP
*** RCHRES Monthly values of water temperature (deg F)
*** x - x T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12
1 36 36. 38. 41. 54. 54. 71. 71. 67. 56. 48. 40.
END MON-WATEMP

END RCHRES

FTABLES

FTABLE 5
rows cols ***
8 4
depth area volume outflow1 ***
0. 0.5 0. 0.
0.08 0.51 0.04 0.42
0.78 0.58 0.42 19.37
0.98 0.72 0.54 28.12
1.22 1.83 0.98 37.5
1.47 1.88 1.43 69.22
25.16 7.16 108.59 37025.94
48.85 12.44 340.75 171335.36
END FTABLE 5

FTABLE 2
rows cols ***
8 4
depth area volume outflow1 ***
0. 7.16 0. 0.
0.12 7.26 0.9 1.39
1.25 8.12 9.53 64.02
1.56 9.55 12.09 92.86
1.95 25.19 21.79 121.58
2.34 25.78 31.72 223.49
40.14 83.77 2102.4 106152.88
77.94 141.76 6365.04 470254.69
END FTABLE 2

FTABLE 11
rows cols ***
8 4
depth area volume outflow1 ***
0. 3.26 0. 0.
0.3 3.29 0.99 9.53
3.03 3.53 10.28 439.83
3.79 3.93 12.97 637.48
4.73 10.81 23.12 814.2
5.68 10.98 33.44 1488.53
97.5 27.14 1783.38 591899.81
189.32 43.3 5017.42 2407669.5
END FTABLE 11

FTABLE 6
rows cols ***
8 4
depth area volume outflow1 ***
0. 1.31 0. 0.

0.12	1.33	0.15	1.62
1.16	1.49	1.62	74.52
1.45	1.77	2.06	108.09
1.81	4.63	3.72	141.9
2.17	4.75	5.41	261.
37.27	15.81	366.17	126192.59
72.36	26.87	1115.14	563004.38

END FTABLE 6

FTABLE 7

rows cols	***				
8 4	depth	area	volume	outflow1	***
0.	0.49	0.	0.	0.	
0.11	0.5	0.05	1.26		
1.07	0.56	0.56	58.05		
1.33	0.67	0.71	84.21		
1.66	1.75	1.29	110.89		
2.	1.79	1.88	204.1		
34.29	6.14	130.03	100712.87		
66.58	10.49	398.56	452873.5		

END FTABLE 7

FTABLE 18

rows cols	***				
8 4	depth	area	volume	outflow1	***
0.	3.76	0.	0.	0.	
0.1	3.81	0.39	0.98		
1.03	4.32	4.16	45.13		
1.29	5.16	5.3	65.48		
1.61	13.44	9.57	86.32		
1.93	13.79	13.96	158.93		
33.2	47.69	975.22	79048.95		
64.47	81.6	2996.67	356522.59		

END FTABLE 18

FTABLE 8

rows cols	***				
8 4	depth	area	volume	outflow1	***
0.	0.23	0.	0.	0.	
0.08	0.24	0.02	0.5		
0.82	0.27	0.21	23.04		
1.02	0.33	0.27	33.45		
1.28	0.86	0.48	44.51		
1.54	0.88	0.71	82.12		
26.38	3.3	52.74	43369.79		
51.23	5.73	164.93	199829.44		

END FTABLE 8

FTABLE 9

rows cols	***				
8 4	depth	area	volume	outflow1	***
0.	14.36	0.	0.	0.	
0.33	14.47	4.76	26.2		
3.3	15.48	49.24	1210.05		
4.13	17.16	62.13	1753.79		
5.16	47.42	110.68	2235.8		
6.19	48.12	159.96	4085.91		
106.25	116.09	8375.461601995.63			
206.31	184.07	23392.69	6463532.		

END FTABLE 9

FTABLE 20

```

rows cols      ***
8   4
depth    area    volume  outflowl ***
0.      2.89     0.       0.
0.09    2.93     0.27    0.96
0.94    3.34     2.94    44.5
1.18    4.02     3.74    64.57
1.48    10.42    6.78   85.42
1.77    10.7     9.9    157.4
30.41   38.13   709.04  80072.72
59.04   65.56   2193.64 364147.03

```

END FTABLE 20

```

FTABLE    12
rows cols      ***
8   4
depth    area    volume  outflowl ***
0.      6.04     0.       0.
0.17   6.11     1.01    1.5
1.66   6.73     10.59   69.05
2.07   7.76     13.42   100.11
2.59   20.79    24.08   129.87
3.11   21.22    34.96   238.24
53.37  62.93   2149.78 106179.91
103.63 104.64  6360.75 457699.72

```

END FTABLE 12

```

FTABLE    21
rows cols      ***
8   4
depth    area    volume  outflowl ***
0.      12.59    0.       0.
0.29   12.69    3.62    17.14
2.86   13.65    37.55   791.48
3.58   15.24    47.41   1147.17
4.47   41.88    84.57   1467.07
5.37   42.54    122.32  2682.85
92.12  106.91  6605.41077064.75
178.88 171.28  18673.24 4404908.5

```

END FTABLE 21

```

FTABLE    3
rows cols      ***
8   4
depth    area    volume  outflowl ***
0.      12.97    0.       0.
0.36   13.06    4.64    34.22
3.57   13.94    47.97   1580.45
4.46   15.39    60.51   2290.61
5.57   42.66    107.71  2915.45
6.69   43.27    155.6   5326.15
114.79 102.15  8016.042062898.88
222.9   161.04  22242.41 8262730.

```

END FTABLE 3

```

FTABLE    24
rows cols      ***
8   4
depth    area    volume  outflowl ***
0.      1.99     0.       0.
0.1     2.02     0.2     1.04
0.98   2.29     2.1     47.75
1.23   2.75     2.67   69.29
1.54   7.14     4.84   91.52
1.84   7.33     7.06   168.57
31.63  25.76   499.85  84886.69

```

61.42 44.19 1541.73 384609.47
END FTABLE 24

FTABLE 16
rows cols ***
8 4
depth area volume outflowl ***
0. 0.61 0. 0.
0.09 0.62 0.05 0.42
0.86 0.71 0.57 19.48
1.08 0.86 0.72 28.27
1.35 2.2 1.31 37.54
1.62 2.27 1.91 69.23
27.83 8.32 140.66 36045.24
54.04 14.38 438.1 165276.03

END FTABLE 16

FTABLE 10
rows cols ***
8 4
depth area volume outflowl ***
0. 1.07 0. 0.
0.3 1.08 0.33 9.53
3.03 1.16 3.38 439.95
3.79 1.29 4.27 637.66
4.73 3.56 7.61 814.43
5.68 3.61 11.01 1488.96
97.51 8.93 587.14 592066.81
189.34 14.26 1651.882408348.25

END FTABLE 10

FTABLE 14
rows cols ***
8 4
depth area volume outflowl ***
0. 0.94 0. 0.
0.08 0.95 0.08 0.52
0.84 1.1 0.85 23.87
1.05 1.33 1.09 34.65
1.31 3.43 1.97 46.07
1.57 3.53 2.88 84.98
26.96 13.08 213.73 44612.25
52.36 22.64 667.22 205137.84

END FTABLE 14

FTABLE 28
rows cols ***
8 4
depth area volume outflowl ***
0. 4.01 0. 0.
0.11 4.07 0.43 1.57
1.07 4.59 4.61 72.34
1.34 5.47 5.86 104.95
1.68 14.29 10.59 138.16
2.01 14.65 15.44 254.28
34.51 50.04 1066.68 125263.85
67.01 85.42 3267.92 562912.81

END FTABLE 28

FTABLE 25
rows cols ***
8 4
depth area volume outflowl ***
0. 4.76 0. 0.
0.24 4.8 1.16 11.94
2.42 5.2 12.05 551.08

3.03	5.86	15.23	798.79
3.78	15.98	27.22	1025.62
4.54	16.26	39.41	1877.19
77.91	42.92	2210.34	776335.31
151.29	69.58	6337.6	3226482.

END FTABLE 25

FTABLE 30

rows	cols	***				
8	4	depth	area	volume	outflow1	***
		0.	1.08	0.	0.	
		0.19	1.09	0.21	4.97	
		1.92	1.19	2.18	229.14	
		2.4	1.36	2.76	332.18	
		3.	3.68	4.95	429.12	
		3.6	3.75	7.17	786.46	
		61.78	10.62	425.21	340056.75	
		119.97	17.49	1243.011445264.88		

END FTABLE 30

FTABLE 29

rows	cols	***				
8	4	depth	area	volume	outflow1	***
		0.	8.25	0.	0.	
		0.26	8.32	2.14	9.26	
		2.58	8.98	22.24	427.55	
		3.23	10.09	28.1	619.71	
		4.03	27.6	50.18	794.44	
		4.84	28.06	72.62	1453.57	
		83.09	72.68	4013.75	594193.5	
		161.34	117.3	11446.312454281.75		

END FTABLE 29

FTABLE 34

rows	cols	***				
8	4	depth	area	volume	outflow1	***
		0.	16.12	0.	0.	
		0.14	16.32	2.23	2.71	
		1.38	18.16	23.58	125.11	
		1.72	21.21	29.91	181.44	
		2.15	56.25	53.83	236.77	
		2.58	57.52	78.29	434.91	
		44.29	181.	5052.59	201926.52	
		86.	304.48	15177.07	886155.	

END FTABLE 34

FTABLE 26

rows	cols	***				
8	4	depth	area	volume	outflow1	***
		0.	1.73	0.	0.	
		0.24	1.75	0.42	13.78	
		2.41	1.89	4.37	636.11	
		3.01	2.13	5.52	922.04	
		3.77	5.82	9.87	1183.98	
		4.52	5.92	14.3	2167.06	
		77.62	15.65	802.5	896801.69	
		150.72	25.37	2301.66	3728427.5	

END FTABLE 26

FTABLE 27

rows	cols	***				
8	4	depth	area	volume	outflow1	***

depth	area	volume	outflow1	***
0.	1.6	0.	0.	
0.09	1.62	0.14	0.76	
0.89	1.86	1.53	34.98	
1.11	2.25	1.95	50.77	
1.39	5.8	3.54	67.33	
1.66	5.96	5.17	124.13	
28.55	21.69	376.92	64186.03	
55.43	37.43	1171.66	293594.81	

END FTABLE 27

FTABLE	35			
rows	cols	***		
8	4			
depth	area	volume	outflow1	***
0.	5.14	0.	0.	
0.11	5.22	0.58	1.26	
1.11	5.88	6.14	58.09	
1.39	6.98	7.8	84.26	
1.74	18.27	14.09	110.77	
2.09	18.73	20.53	203.8	
35.86	63.16	1403.43	99454.28	
69.64	107.58	4286.76	445317.	

END FTABLE 35

FTABLE	23			
rows	cols	***		
8	4			
depth	area	volume	outflow1	***
0.	8.95	0.	0.	
0.27	9.03	2.42	16.93	
2.69	9.74	25.12	781.42	
3.36	10.91	31.73	1132.61	
4.2	29.89	56.63	1450.57	
5.04	30.38	81.94	2653.52	
86.52	77.76	4487.55	1076983.5	
168.	125.15	12753.92	4431209.5	

END FTABLE 23

FTABLE	22			
rows	cols	***		
8	4			
depth	area	volume	outflow1	***
0.	1.53	0.	0.	
0.27	1.55	0.41	29.51	
2.65	1.67	4.24	1362.04	
3.31	1.87	5.36	1974.2	
4.14	5.12	9.57	2529.21	
4.97	5.21	13.85	4626.96	
85.36	13.38	760.71882358.38		
165.74	21.55	2164.41	7754818.5	

END FTABLE 22

FTABLE	33			
rows	cols	***		
8	4			
depth	area	volume	outflow1	***
0.	3.38	0.	0.	
0.1	3.43	0.35	1.49	
1.03	3.88	3.75	68.55	
1.29	4.63	4.76	99.46	
1.61	12.08	8.61	131.12	
1.94	12.39	12.56	241.4	
33.24	42.86	877.26	120047.8	
64.53	73.33	2695.5	541396.63	

END FTABLE 33

FTABLE 19
 rows cols ***
 8 4
 depth area volume outflowl ***
 0. 0.84 0. 0.
 0.08 0.86 0.07 0.48
 0.79 0.99 0.73 22.22
 0.99 1.21 0.93 32.26
 1.24 3.1 1.68 42.99
 1.49 3.19 2.46 79.35
 25.51 12.07 185.82 42297.38
 49.53 20.96 582.56 195503.67

END FTABLE 19

FTABLE 17
 rows cols ***
 8 4
 depth area volume outflowl ***
 0. 11.77 0. 0.
 0.29 11.87 3.47 12.92
 2.94 12.75 36.03 596.27
 3.67 14.22 45.49 864.23
 4.59 39.1 81.12 1104.56
 5.51 39.71 117.32 2019.66
 94.61 99.04 6298.56 807167.
 183.7 158.37 17765.86 3292745.5

END FTABLE 17

FTABLE 15
 rows cols ***
 8 4
 depth area volume outflowl ***
 0. 1.27 0. 0.
 0.09 1.29 0.12 0.55
 0.93 1.47 1.27 25.49
 1.16 1.77 1.62 36.99
 1.45 4.58 2.93 48.96
 1.74 4.71 4.28 90.23
 29.91 16.86 307.99 46098.44
 58.08 29.01 954.04 209962.34

END FTABLE 15

FTABLE 36
 rows cols ***
 8 4
 depth area volume outflowl ***
 0. 15.34 0. 0.
 0.15 15.53 2.26 1.7
 1.46 17.21 23.83 78.43
 1.83 20.02 30.22 113.73
 2.29 53.27 54.33 148.11
 2.75 54.44 78.98 271.94
 47.14 167.9 5014.14 124504.
 91.53 281.36 14986.24 543132.56

END FTABLE 36

FTABLE 13
 rows cols ***
 8 4
 depth area volume outflowl ***
 0. 2.38 0. 0.
 0.13 2.41 0.32 2.38
 1.32 2.69 3.34 109.63
 1.65 3.15 4.24 158.99
 2.06 8.34 7.64 207.77

2.47	8.54	11.12	381.77
42.43	27.24	725.91	179011.47
82.39	45.94	2188.04	788834.5

END FTABLE 13

FTABLE 4

rows	cols	***				
8	4	depth	area	volume	outflow1	***
0.	17.21	0.	0.	0.	0.	0.
0.34	17.34	5.92	29.92	1381.71	2002.57	2550.98
3.42	18.53	61.19	1381.71	4661.15	4661.15	4661.15
4.28	20.5	77.19	2002.57	10318.971816834.88	10318.971816834.88	10318.971816834.88
5.35	56.73	137.46	2550.98	28730.99	7304911.5	7304911.5
6.42	57.55	198.61	4661.15			
110.23	137.43	10318.971816834.88				
214.04	217.3	28730.99	7304911.5			

END FTABLE 4

FTABLE 1

rows	cols	***				
8	4	depth	area	volume	outflow1	***
0.	2.45	0.	0.	0.	0.	0.
0.36	2.46	0.88	66.08	3051.94	4423.29	5629.84
3.57	2.63	9.05	3051.94	10284.98	1512.44	3983164.
4.46	2.9	11.42	4423.29	20.33	4196.41	4196.41
5.57	8.05	20.33	5629.84	30.37	15953260.	15953260.
6.69	8.16	29.36	10284.98			
114.84	19.26	1512.44	3983164.			
223.	30.37	4196.41	15953260.			

END FTABLE 1

FTABLE 31

rows	cols	***				
8	4	depth	area	volume	outflow1	***
0.	10.17	0.	0.	0.	0.	0.
0.2	10.27	2.04	5.7	21.37	263.23	263.23
2.	11.21	21.37	263.23	27.03	381.6	381.6
2.5	12.78	27.03	381.6	48.41	492.41	492.41
3.12	34.55	48.41	492.41	70.19	902.23	902.23
3.75	35.2	70.19	902.23	4119.7	386986.03	386986.03
64.33	98.49	4119.7	386986.03	12002.85	1638310.	1638310.
124.91	161.77	12002.85	1638310.			

END FTABLE 31

FTABLE 32

rows	cols	***				
8	4	depth	area	volume	outflow1	***
0.	7.8	0.	0.	0.	0.	0.
0.23	7.87	1.77	11.	18.49	507.71	507.71
2.26	8.54	18.49	507.71	23.38	735.94	735.94
2.83	9.66	23.38	735.94	41.8	946.53	946.53
3.54	26.28	41.8	946.53	60.55	1733.06	1733.06
4.24	26.75	60.55	1733.06	3449.84	725707.	725707.
72.85	72.06	3449.84	725707.	9947.353035599.25	9947.353035599.25	9947.353035599.25
141.45	117.36	9947.353035599.25	9947.353035599.25			

END FTABLE 32

END FTABLES

COPY

TIMESERIES

Copy-opn***

*** x - x NPT NMN

1 2 0 7
END TIMESERIES

END COPY

EXT SOURCES

<-Volume-> <Member> SsysSgap<-Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> x <Name> x tem strg<-factor->strg <Name> x x <Name> x x ***
*** Met Seg 128999
WDM2 128 PREC ENGLZERO SAME PERLND 101 125 EXTNL PREC
WDM2 127 ATEM ENGL SAME PERLND 101 125 EXTNL GATMP
WDM2 130 PEVT ENGL SAME PERLND 101 125 EXTNL PETINP
*** Met Seg 128999
WDM2 128 PREC ENGLZERO SAME IMPLND 101 105 EXTNL PREC
WDM2 127 ATEM ENGL SAME IMPLND 101 105 EXTNL GATMP
WDM2 130 PEVT ENGL SAME IMPLND 101 105 EXTNL PETINP

WDM1 10 FLOW ENGL 0.0826 SAME RCHRES 11 INFLOW IVOL
WDM1 18 ECOL ENGL DIV RCHRES 11 INFLOW IDQAL
WDM1 7002 ECOL ENGL DIV RCHRES 11 INFLOW IDQAL
WDM1 9 FLOW ENGL 0.0826 SAME RCHRES 7 INFLOW IVOL
WDM1 17 ECOL ENGL DIV RCHRES 7 INFLOW IDQAL
WDM1 7004 ECOL ENGL DIV RCHRES 9 INFLOW IDQAL
WDM1 15 ECOL ENGL DIV RCHRES 12 INFLOW IDQAL
WDM1 16 ECOL ENGL DIV RCHRES 12 INFLOW IDQAL
WDM1 6 FLOW ENGL 0.0826 SAME RCHRES 24 INFLOW IVOL
WDM1 14 ECOL ENGL DIV RCHRES 24 INFLOW IDQAL
WDM1 20 ECOL ENGL DIV RCHRES 16 INFLOW IDQAL
WDM1 4 FLOW ENGL 0.0826 SAME RCHRES 10 INFLOW IVOL
WDM1 13 ECOL ENGL DIV RCHRES 10 INFLOW IDQAL
WDM1 11 FLOW ENGL 0.0826 SAME RCHRES 28 INFLOW IVOL
WDM1 19 ECOL ENGL DIV RCHRES 28 INFLOW IDQAL
WDM1 7007 ECOL ENGL DIV RCHRES 30 INFLOW IDQAL
WDM1 2 FLOW ENGL 0.0826 SAME RCHRES 26 INFLOW IVOL
WDM1 21 FLOW ENGL 0.0826 SAME RCHRES 26 INFLOW IVOL
WDM1 24 ECOL ENGL DIV RCHRES 26 INFLOW IDQAL
WDM1 7001 ECOL ENGL DIV RCHRES 26 INFLOW IDQAL
WDM1 7003 FLOW ENGL 0.0826 SAME RCHRES 26 INFLOW IVOL
WDM1 7008 ECOL ENGL DIV RCHRES 26 INFLOW IDQAL
WDM1 7009 ECOL ENGL DIV RCHRES 26 INFLOW IDQAL
WDM1 7006 ECOL ENGL DIV RCHRES 19 INFLOW IDQAL
WDM1 3 FLOW ENGL 0.0826 SAME RCHRES 15 INFLOW IVOL
WDM1 7005 ECOL ENGL DIV RCHRES 1 INFLOW IDQAL
WDM1 7011 ECOL ENGL DIV RCHRES 12 INFLOW IDQAL
WDM1 7012 ECOL ENGL DIV RCHRES 12 INFLOW IDQAL
WDM1 7013 ECOL ENGL DIV RCHRES 16 INFLOW IDQAL
END EXT SOURCES

SCHEMATIC

<-Volume->	<-Area-->	<-Volume->	<ML#>	***	<sb>
<Name> x	<-factor->	<Name> x	***	***	x x
PERLND 124		6	RCHRES	5	2
PERLND 125		161	RCHRES	5	2
IMPLND 105		161	RCHRES	5	1
PERLND 121		105	RCHRES	5	2
PERLND 122		29	RCHRES	5	2
PERLND 123		875	RCHRES	5	2
PERLND 124		21	RCHRES	2	2
PERLND 125		453	RCHRES	2	2
IMPLND 105		453	RCHRES	2	1
PERLND 121		1140	RCHRES	2	2
PERLND 122		143	RCHRES	2	2
PERLND 123		1401	RCHRES	2	2
PERLND 119		25	RCHRES	11	2
PERLND 120		45	RCHRES	11	2
IMPLND 104		45	RCHRES	11	1

PERLND	116	824	RCHRES	11	2
PERLND	117	130	RCHRES	11	2
PERLND	118	663	RCHRES	11	2
PERLND	124	7	RCHRES	6	2
PERLND	125	247	RCHRES	6	2
IMPLND	105	247	RCHRES	6	1
PERLND	121	225	RCHRES	6	2
PERLND	122	17	RCHRES	6	2
PERLND	123	702	RCHRES	6	2
PERLND	119	43	RCHRES	7	2
PERLND	120	53	RCHRES	7	2
IMPLND	104	53	RCHRES	7	1
PERLND	116	343	RCHRES	7	2
PERLND	117	48	RCHRES	7	2
PERLND	118	579	RCHRES	7	2
PERLND	114	12	RCHRES	18	2
PERLND	115	15	RCHRES	18	2
IMPLND	103	15	RCHRES	18	1
PERLND	111	637	RCHRES	18	2
PERLND	112	62	RCHRES	18	2
PERLND	113	417	RCHRES	18	2
PERLND	119	15	RCHRES	8	2
PERLND	120	29	RCHRES	8	2
IMPLND	104	29	RCHRES	8	1
PERLND	116	388	RCHRES	8	2
PERLND	117	59	RCHRES	8	2
PERLND	118	743	RCHRES	8	2
PERLND	119		RCHRES	9	2
PERLND	120		RCHRES	9	2
IMPLND	104		RCHRES	9	1
PERLND	116	27	RCHRES	9	2
PERLND	117	4	RCHRES	9	2
PERLND	118	15	RCHRES	9	2
RCHRES	7		RCHRES	9	3
RCHRES	8		RCHRES	9	3
PERLND	114	4	RCHRES	20	2
PERLND	115	27	RCHRES	20	2
IMPLND	103	27	RCHRES	20	1
PERLND	111	445	RCHRES	20	2
PERLND	112	86	RCHRES	20	2
PERLND	113	1403	RCHRES	20	2
PERLND	119	87	RCHRES	12	2
PERLND	120	142	RCHRES	12	2
IMPLND	104	142	RCHRES	12	1
PERLND	116	788	RCHRES	12	2
PERLND	117	119	RCHRES	12	2
PERLND	118	526	RCHRES	12	2
PERLND	114	21	RCHRES	21	2
PERLND	115	27	RCHRES	21	2
IMPLND	103	27	RCHRES	21	1
PERLND	111	477	RCHRES	21	2
PERLND	112	92	RCHRES	21	2
PERLND	113	899	RCHRES	21	2
PERLND	124		RCHRES	3	2
PERLND	125	14	RCHRES	3	2
IMPLND	105	14	RCHRES	3	1
PERLND	111	64	RCHRES	3	2
PERLND	123	121	RCHRES	3	2
RCHRES	5		RCHRES	3	3
RCHRES	6		RCHRES	3	3
PERLND	114	238	RCHRES	24	2
PERLND	115	201	RCHRES	24	2
IMPLND	103	201	RCHRES	24	1
PERLND	111	711	RCHRES	24	2
PERLND	112	66	RCHRES	24	2
PERLND	113	838	RCHRES	24	2

PERLND	114	21	RCHRES	16	2
PERLND	115	81	RCHRES	16	2
IMPLND	103	81	RCHRES	16	1
PERLND	111	1002	RCHRES	16	2
PERLND	112	191	RCHRES	16	2
PERLND	113	871	RCHRES	16	2
PERLND	114	9	RCHRES	10	2
PERLND	115	64	RCHRES	10	2
IMPLND	103	64	RCHRES	10	1
PERLND	111	177	RCHRES	10	2
PERLND	112	48	RCHRES	10	2
PERLND	113	251	RCHRES	10	2
RCHRES	11		RCHRES	10	3
RCHRES	12		RCHRES	10	3
PERLND	114	6	RCHRES	14	2
PERLND	115	20	RCHRES	14	2
IMPLND	103	20	RCHRES	14	1
PERLND	111	326	RCHRES	14	2
PERLND	112	52	RCHRES	14	2
PERLND	113	352	RCHRES	14	2
RCHRES	9		RCHRES	14	3
RCHRES	10		RCHRES	14	3
PERLND	109	24	RCHRES	28	2
PERLND	110	69	RCHRES	28	2
IMPLND	102	69	RCHRES	28	1
PERLND	106	1177	RCHRES	28	2
PERLND	107	147	RCHRES	28	2
PERLND	108	1241	RCHRES	28	2
PERLND	109	18	RCHRES	25	2
PERLND	110	334	RCHRES	25	2
IMPLND	102	334	RCHRES	25	1
PERLND	106	792	RCHRES	25	2
PERLND	107	81	RCHRES	25	2
PERLND	108	918	RCHRES	25	2
PERLND	104	78	RCHRES	30	2
PERLND	105	1109	RCHRES	30	2
IMPLND	101	1109	RCHRES	30	1
PERLND	101	683	RCHRES	30	2
PERLND	102	103	RCHRES	30	2
PERLND	103	1541	RCHRES	30	2
PERLND	104	36	RCHRES	29	2
PERLND	105	153	RCHRES	29	2
IMPLND	101	153	RCHRES	29	1
PERLND	101	1579	RCHRES	29	2
PERLND	102	240	RCHRES	29	2
PERLND	103	3242	RCHRES	29	2
PERLND	109		RCHRES	34	2
PERLND	110	255	RCHRES	34	2
IMPLND	102	255	RCHRES	34	1
PERLND	106	46	RCHRES	34	2
PERLND	108	30	RCHRES	34	2
RCHRES	30		RCHRES	34	3
RCHRES	29		RCHRES	34	3
PERLND	109	15	RCHRES	26	2
PERLND	110	231	RCHRES	26	2
IMPLND	102	231	RCHRES	26	1
PERLND	106	416	RCHRES	26	2
PERLND	107	13	RCHRES	26	2
PERLND	108	220	RCHRES	26	2
RCHRES	34		RCHRES	26	3
PERLND	109	32	RCHRES	27	2
PERLND	110	232	RCHRES	27	2
IMPLND	102	232	RCHRES	27	1
PERLND	106	481	RCHRES	27	2
PERLND	107	56	RCHRES	27	2
PERLND	108	773	RCHRES	27	2

RCHRES	25		RCHRES	27	3
RCHRES	26		RCHRES	27	3
PERLND	109	2	RCHRES	35	2
PERLND	110	11	RCHRES	35	2
PERLND	107	5	RCHRES	35	2
PERLND	108	11	RCHRES	35	2
RCHRES	28		RCHRES	35	3
RCHRES	27		RCHRES	35	3
PERLND	111	77	RCHRES	23	2
PERLND	112	7	RCHRES	23	2
PERLND	113	87	RCHRES	23	2
RCHRES	35		RCHRES	23	3
PERLND	114	9	RCHRES	22	2
PERLND	115	25	RCHRES	22	2
IMPLND	102	25	RCHRES	22	1
PERLND	111	385	RCHRES	22	2
PERLND	112	95	RCHRES	22	2
PERLND	113	507	RCHRES	22	2
RCHRES	24		RCHRES	22	3
RCHRES	23		RCHRES	22	3
PERLND	111	7	RCHRES	33	2
PERLND	112	2	RCHRES	33	2
PERLND	113	3	RCHRES	33	2
RCHRES	21		RCHRES	33	3
RCHRES	22		RCHRES	33	3
PERLND	114	3	RCHRES	19	2
PERLND	115	28	RCHRES	19	2
IMPLND	103	28	RCHRES	19	1
PERLND	111	289	RCHRES	19	2
PERLND	112	28	RCHRES	19	2
PERLND	113	430	RCHRES	19	2
RCHRES	33		RCHRES	19	3
PERLND	114	18	RCHRES	17	2
PERLND	115	197	RCHRES	17	2
IMPLND	103	197	RCHRES	17	1
PERLND	111	407	RCHRES	17	2
PERLND	112	93	RCHRES	17	2
PERLND	113	1285	RCHRES	17	2
RCHRES	20		RCHRES	17	3
RCHRES	19		RCHRES	17	3
PERLND	114	2	RCHRES	15	2
PERLND	115	136	RCHRES	15	2
IMPLND	103	136	RCHRES	15	1
PERLND	111	334	RCHRES	15	2
PERLND	112	22	RCHRES	15	2
PERLND	113	187	RCHRES	15	2
RCHRES	18		RCHRES	15	3
RCHRES	17		RCHRES	15	3
PERLND	114	3	RCHRES	36	2
PERLND	115	7	RCHRES	36	2
IMPLND	103	7	RCHRES	36	1
PERLND	111	40	RCHRES	36	2
PERLND	112	7	RCHRES	36	2
PERLND	113	86	RCHRES	36	2
RCHRES	16		RCHRES	36	3
RCHRES	15		RCHRES	36	3
PERLND	111	4	RCHRES	13	2
PERLND	113	2	RCHRES	13	2
RCHRES	36		RCHRES	13	3
PERLND	124	9	RCHRES	4	2
PERLND	125		RCHRES	4	2
IMPLND	105		RCHRES	4	1
PERLND	122	18	RCHRES	4	2
PERLND	123	375	RCHRES	4	2
RCHRES	14		RCHRES	4	3
RCHRES	13		RCHRES	4	3

PERLND	124	35	RCHRES	1	2
PERLND	125	84	RCHRES	1	2
IMPLND	105	84	RCHRES	1	1
PERLND	111	388	RCHRES	1	2
PERLND	112	18	RCHRES	1	2
PERLND	113	359	RCHRES	1	2
RCHRES	3		RCHRES	1	3
RCHRES	4		RCHRES	1	3
PERLND	124	20	RCHRES	31	2
PERLND	125	155	RCHRES	31	2
IMPLND	105	155	RCHRES	31	1
PERLND	121	530	RCHRES	31	2
PERLND	122	43	RCHRES	31	2
PERLND	123	298	RCHRES	31	2
RCHRES	2		RCHRES	31	3
RCHRES	1		RCHRES	31	3
PERLND	125	16	RCHRES	32	2
IMPLND	105	16	RCHRES	32	1
PERLND	121	24	RCHRES	32	2
PERLND	122	3	RCHRES	32	2
PERLND	123	4	RCHRES	32	2
RCHRES	31		RCHRES	32	3
PERLND	105	1262	COPY	1	90
IMPLND	101	1262	COPY	1	91
PERLND	101	2262	COPY	1	90
PERLND	102	343	COPY	1	90
PERLND	103	4783	COPY	1	90
PERLND	104	114	COPY	1	90
PERLND	110	1132	COPY	1	90
IMPLND	102	1146	COPY	1	91
PERLND	106	2912	COPY	1	90
PERLND	107	302	COPY	1	90
PERLND	108	3193	COPY	1	90
PERLND	109	91	COPY	1	90
PERLND	115	828	COPY	1	90
IMPLND	103	803	COPY	1	91
PERLND	111	5770	COPY	1	90
PERLND	112	869	COPY	1	90
PERLND	113	7977	COPY	1	90
PERLND	114	346	COPY	1	90
PERLND	120	269	COPY	1	90
IMPLND	104	74	COPY	1	91
PERLND	116	2370	COPY	1	90
PERLND	117	360	COPY	1	90
PERLND	118	2526	COPY	1	90
PERLND	119	145	COPY	1	90
PERLND	125	1032	COPY	1	90
IMPLND	105	1262	COPY	1	91
PERLND	121	2205	COPY	1	90
PERLND	122	253	COPY	1	90
PERLND	123	3776	COPY	1	90
PERLND	124	125	COPY	1	90
PERLND	125	1131	COPY	2	90
IMPLND	105	1131	COPY	2	91
PERLND	121	2024	COPY	2	90
PERLND	122	253	COPY	2	90
PERLND	123	3776	COPY	2	90
PERLND	124	99	COPY	2	90
PERLND	111	5770	COPY	2	90
PERLND	112	869	COPY	2	90
PERLND	113	7977	COPY	2	90
PERLND	114	346	COPY	2	90
PERLND	115	828	COPY	2	90
IMPLND	103	803	COPY	2	91
PERLND	119	171	COPY	2	90
PERLND	120	270	COPY	2	90

IMPLND	104		270	COPY	2	91
PERLND	116		2370	COPY	2	90
PERLND	117		360	COPY	2	90
PERLND	118		2526	COPY	2	90
IMPLND	102		1146	COPY	2	91
PERLND	109		92	COPY	2	90
PERLND	110		1132	COPY	2	90
PERLND	107		302	COPY	2	90
PERLND	108		3193	COPY	2	90
PERLND	106		2912	COPY	2	90
PERLND	104		114	COPY	2	90
PERLND	105		1262	COPY	2	90
IMPLND	101		1262	COPY	2	91
PERLND	101		2262	COPY	2	90
PERLND	102		343	COPY	2	90
PERLND	103		4783	COPY	2	90

END SCHEMATIC

EXT TARGETS

<-Volume->	<-Grp>	<-Member->	<-Mult-->	Tran	<-Volume->	<Member>	Tsys	Aggr	Amd	***
<Name>	x	<Name>	x	x<-factor->	strg	<Name>	x	<Name>	qf	tem strg strg***
RCHRES	14	GQUAL	DQAL	1 1		AVER	WDM1	1644	DQAL	1 ENGL AGGR REPL
RCHRES	29	GQUAL	DQAL	1 1		AVER	WDM1	1643	DQAL	1 ENGL AGGR REPL
RCHRES	34	GQUAL	DQAL	1 1		AVER	WDM1	1645	DQAL	1 ENGL AGGR REPL
RCHRES	32	HYDR	RO	1 1		AVER	WDM1	1633	FLOW	1 ENGL AGGR REPL
RCHRES	32	ROFLOW	ROVOL	1 1	2.4108e-4		WDM	1634	SIMQ	1 ENGL AGGR REPL
RCHRES	32	GQUAL	DQAL	1 1		AVER	WDM1	1642	DQAL	1 ENGL AGGR REPL
COPY	2	OUTPUT	MEAN	1 1	2.009E-05		WDM	1635	SURO	1 ENGL AGGR REPL
COPY	2	OUTPUT	MEAN	2 1	2.009E-05		WDM	1636	IFWO	1 ENGL AGGR REPL
COPY	2	OUTPUT	MEAN	3 1	2.009E-05		WDM	1637	AGWO	1 ENGL AGGR REPL
COPY	2	OUTPUT	MEAN	4 1	2.009E-05		WDM	1638	PETX	1 ENGL AGGR REPL
COPY	2	OUTPUT	MEAN	5 1	2.009E-05		WDM	1639	SAET	1 ENGL AGGR REPL
COPY	2	OUTPUT	MEAN	6 1	2.009E-05	AVER	WDM	1640	UZSX	1 ENGL AGGR REPL
COPY	2	OUTPUT	MEAN	7 1	2.009E-05	AVER	WDM	1641	LZSX	1 ENGL AGGR REPL

END EXT TARGETS

MASS-LINK

MASS-LINK	2									
<-Volume->	<-Grp>	<-Member->	<-Mult-->		<-Target vols>	<-Grp>	<-Member->	***		
<Name>		<Name>	x	x<-factor->	<Name>		<Name>	x x	***	
PERLND	PWATER	PERO		0.0833333	RCHRES		INFLOW	IVOL		
PERLND	PWTGAS	PODOXM			RCHRES		INFLOW	OXIF	1	
PERLND	PWTGAS	POHT			RCHRES		INFLOW	IHEAT	1	
PERLND	PEST	SOSDPS	1		RCHRES		INFLOW	ISQAL	1 1	
PERLND	PEST	SOSDPS	1		RCHRES		INFLOW	ISQAL	2 1	
PERLND	PEST	SOSDPS	1		RCHRES		INFLOW	ISQAL	3 1	
PERLND	SEDMNT	SOSED	1	0.05	RCHRES		INFLOW	ISED	1	
PERLND	SEDMNT	SOSED	1	0.55	RCHRES		INFLOW	ISED	2	
PERLND	SEDMNT	SOSED	1	0.4	RCHRES		INFLOW	ISED	3	
PERLND	PQUAL	POQUAL	1		RCHRES		INFLOW	IDQAL	1	
END MASS-LINK	2									

MASS-LINK 2

MASS-LINK	1									
<-Volume->	<-Grp>	<-Member->	<-Mult-->		<-Target vols>	<-Grp>	<-Member->	***		
<Name>		<Name>	x	x<-factor->	<Name>		<Name>	x x	***	
IMPLND	IWATER	SURO		0.0833333	RCHRES		INFLOW	IVOL		
IMPLND	IWTGAS	SODOXM			RCHRES		INFLOW	OXIF	1	
IMPLND	IWTGAS	SOHT			RCHRES		INFLOW	IHEAT	1	
IMPLND	SOLIDs	SOSLD	1	0.05	RCHRES		INFLOW	ISED	1	
IMPLND	SOLIDs	SOSLD	1	0.55	RCHRES		INFLOW	ISED	2	
IMPLND	SOLIDs	SOSLD	1	0.4	RCHRES		INFLOW	ISED	3	
IMPLND	IQUAL	SOQUAL	1		RCHRES		INFLOW	IDQAL	1	
END MASS-LINK	1									

MASS-LINK 3

```

<-Volume-> <-Grp> <-Member-><--Mult--> <-Target vols> <-Grp> <-Member-> ***  

<Name> <Name> x x<-factor-> <Name> <Name> x x ***  

RCHRES ROFLOW RCHRES INFLOW  

END MASS-LINK 3

MASS-LINK 90
<-Volume-> <-Grp> <-Member-><--Mult--> <-Target vols> <-Grp> <-Member-> ***  

<Name> <Name> x x<-factor-> <Name> <Name> x x ***  

PERLND PWATER SURO COPY INPUT MEAN 1  

PERLND PWATER IFWO COPY INPUT MEAN 2  

PERLND PWATER AGWO COPY INPUT MEAN 3  

PERLND PWATER PET COPY INPUT MEAN 4  

PERLND PWATER TAET COPY INPUT MEAN 5  

PERLND PWATER UZS COPY INPUT MEAN 6  

PERLND PWATER LZS COPY INPUT MEAN 7  

END MASS-LINK 90

MASS-LINK 91
<-Volume-> <-Grp> <-Member-><--Mult--> <-Target vols> <-Grp> <-Member-> ***  

<Name> <Name> x x<-factor-> <Name> <Name> x x ***  

IMPLND IWATER SURO COPY INPUT MEAN 1  

IMPLND IWATER PET COPY INPUT MEAN 4  

IMPLND IWATER IMPEV COPY INPUT MEAN 5  

END MASS-LINK 91
END MASS-LINK

```

END RUN